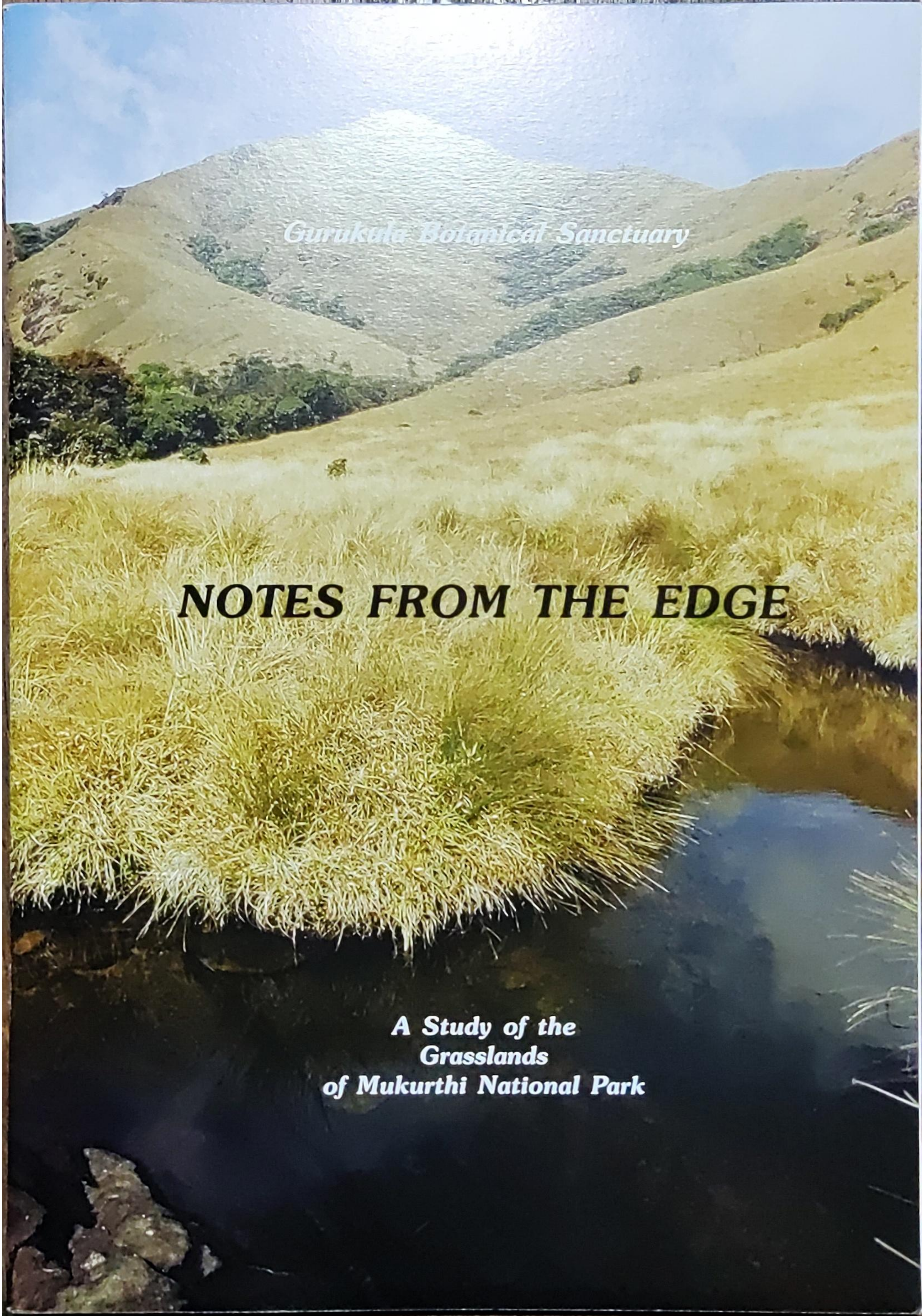


Gurukula Botanical Sanctuary

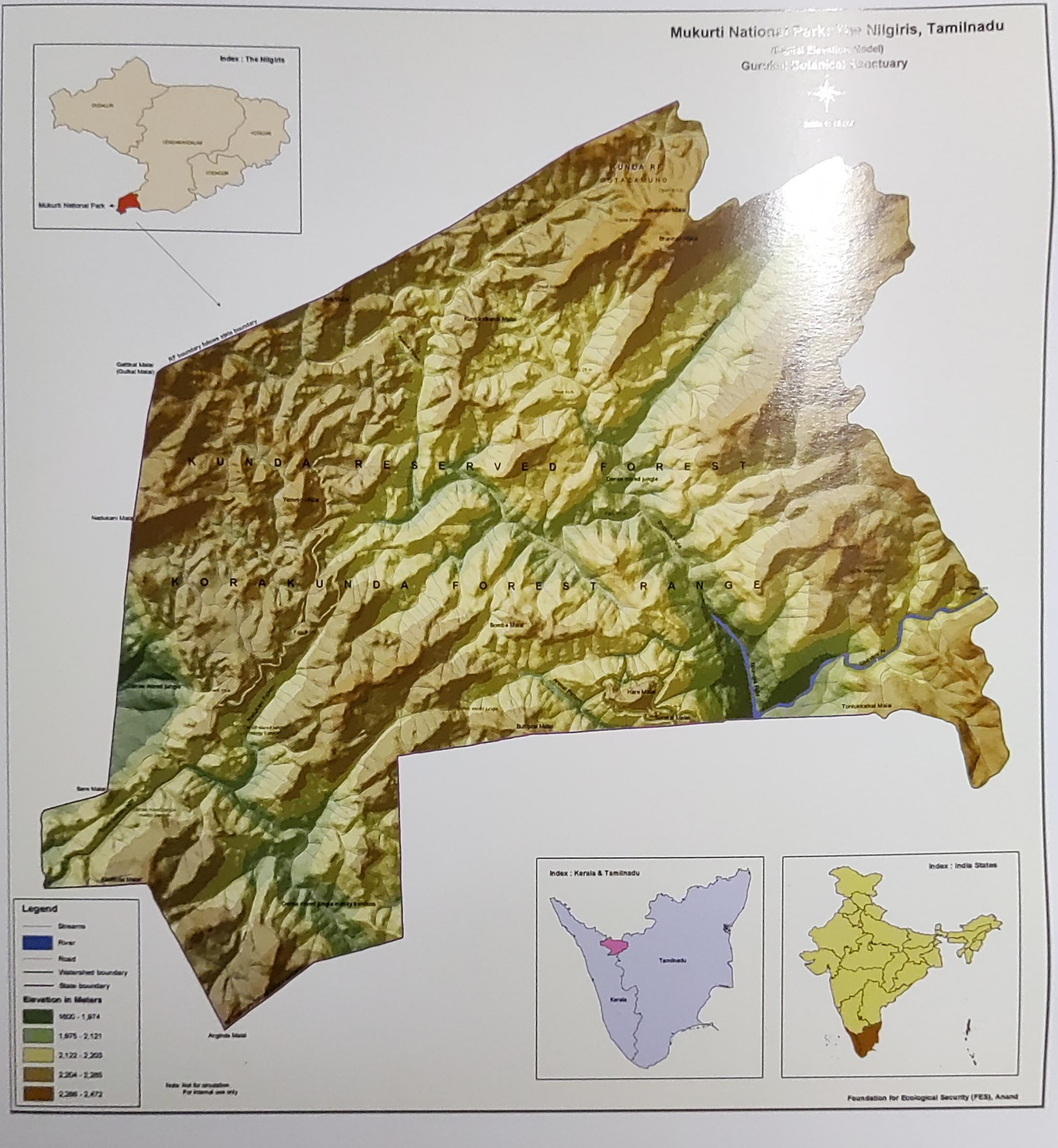
NOTES FROM THE EDGE

A Study of the
Grasslands
of Mukurthi National Park

Mukurti National Park: The Nilgiris, Tamilnadu

(Digital Elevation Model)

Gurukal Botanical Sanctuary


Index : The Nilgiris
GUDALUR
UDHAGAMANDALAM
KOTAGIRI
COONOOR
Mukurti National Park
KUNDA RF
OOTACAMUND
Gattikal Malai
(Gulkal Malai)
RF boundary follows state boundary
Nadukani Malai
KUNDA RESERVED FOREST
Dense mixed jungle
KORAKUNDA FOREST RANGE
Bombe Malai
Hare Malai
Tonkukkakal Malai
Sere Malai
Anginda Malai
Legend
Streams
River
Road
Watershed boundary
State boundary
Elevation in Meters
1800 - 1,974
1,975 - 2,121
2,122 - 2,203
2,204 - 2,285
2,286 - 2,472
Note: Not for circulation.
For internal use only
Index : Kerala & Tamilnadu
Tamilnadu
Kerala
Index : India States
Foundation for Ecological Security (FES), Anand

NOTES FROM THE EDGE

A Study of the Grasslands of Mukurthi National Park

Contents

Contributors ii

Foreword iii

I Essay: Notes from the Edge 1

II Study: The Grasslands of Mukurthi 7

Introduction 7

Flora of the Study Area 10

Anthropogenic Factors Affecting the Flora 12

Historical Information 15

Forest Policies in the Nilgiris 15

Toda and Badaga Grazing Patterns 17

Botanical History 17

- Species Found Then and Now 17

- Species Found Then But Not Now 18

III Questions, Discussion, Recommendations 19

Six Intriguing facts about MNP 19

A National Park for Exotic Species? 19

Points for Discussion and Further Study 20

Does Mukurthi National Park Require Restoration? 21

Strategic Recommendations 22

IV Appendices 23

Further Historical Details of the Park Area 23

Grassland Species Inventory 26

References 40

Contributors

Field Studies: T. Sandilya, Field Coordinator, with help from Deviah Aiama, Anuruddha Jaithirtha, Suprabha Seshan and MNP guard and watchers Nandish, Karuppaiah and Kullan. ***Archival Work***: T. Sandilya, Anuruddha Jaithirtha, Diba Sidiqqi, Suprabha Seshan. ***Identification***: T. Sandilya, Wolfgang Theuerkauf, Laly Joseph and P. Suma. ***Supporting Research***: Suprabha Seshan. ***Consultational Field Visits***: Suresh Jones and Dr. Subba Rao (Foundation for Ecological Security) and Dr. Ankila Hiremath (Ashoka Trust for Research in Environment and Ecology). ***Botanical Consultations***: Bob Stewart, Tanya Balcar, Kiran Raj, Dr. Henry Noltie. ***General Information***: Former Ranger, F. Solomon; Former P. C. C. F Sri S. Subbarayalu, former Wildlife Warden, MNP Dr. Paul Raj; the Wildlife Warden, Mr. Ashok Upreti. Also Bob Stewart and Tanya Balcar, Vattakanal Conservation Trust; Ashfaq Ahmed, Bombay Natural History Society; T. Ravi and Dr. Tarun Chhabra, Nilgiri Wildlife and Environment Association ***Digital Elevation Map***: Ravi, Foundation for Ecological Security. ***Funding***: Foundation for Ecological Security, Anand, Gujarat.

Photo Credits: All photographs taken by T. Sandilya and Suprabha Seshan unless otherwise mentioned.

Botanical Illustrations : T. Sandilya

With thanks to:

The Tamil Nadu Forest Department: PCCF Dr. Sukhdev; Wildlife Wardens: Dr. Paul Raj, Mr. Ashok Upreti; Former PCCF: Sri Subbarayalu; Rangers: late Sri. Ramakrishnan, Sri. Devaraj; Guards & Watchers: Nandish, Kullan, Karuppaiah and Kumar.

Jagdeesh Puppala and other members of Foundation for Ecological Security.

Cover Photograph: Madippumalai, MNP

Back Cover Photograph:

Top - Rhododendrons in the mist, MNP
Middle - Nilgiri Peak, MNP. © Dr. M.S. Mayilvahnan
Bottom - Frog in Hedyotis verticillaris, MNP

Foreword

This document does not conform to the usual report format. Instead, it unfolds in a series of loose natural rubrics that better represent the truth of our experience. We are naturalist-gardeners, not scientists. We look for health, beauty and diversity. We get our hands dirty and in the doing, we nurture. Our attempts at formal research frequently seem clumsy and irrelevant, blunting our senses and leading us nowhere. In contrast, our instincts and our growing sensitivity to Mukurthi's special beauty revealed such wonders and such travesties that the cumbersome process of analysis struggled to keep pace. Anyone who walks in Mukurthi discovers a private magic all their own: a flowing from the present into the past and the future: intuitive, inspirational and precious: encompassing life, round and full, from the detail of a plant and the spoor of tiger to the vertiginous and giddying cliff sides of the Nilgiri Horst.

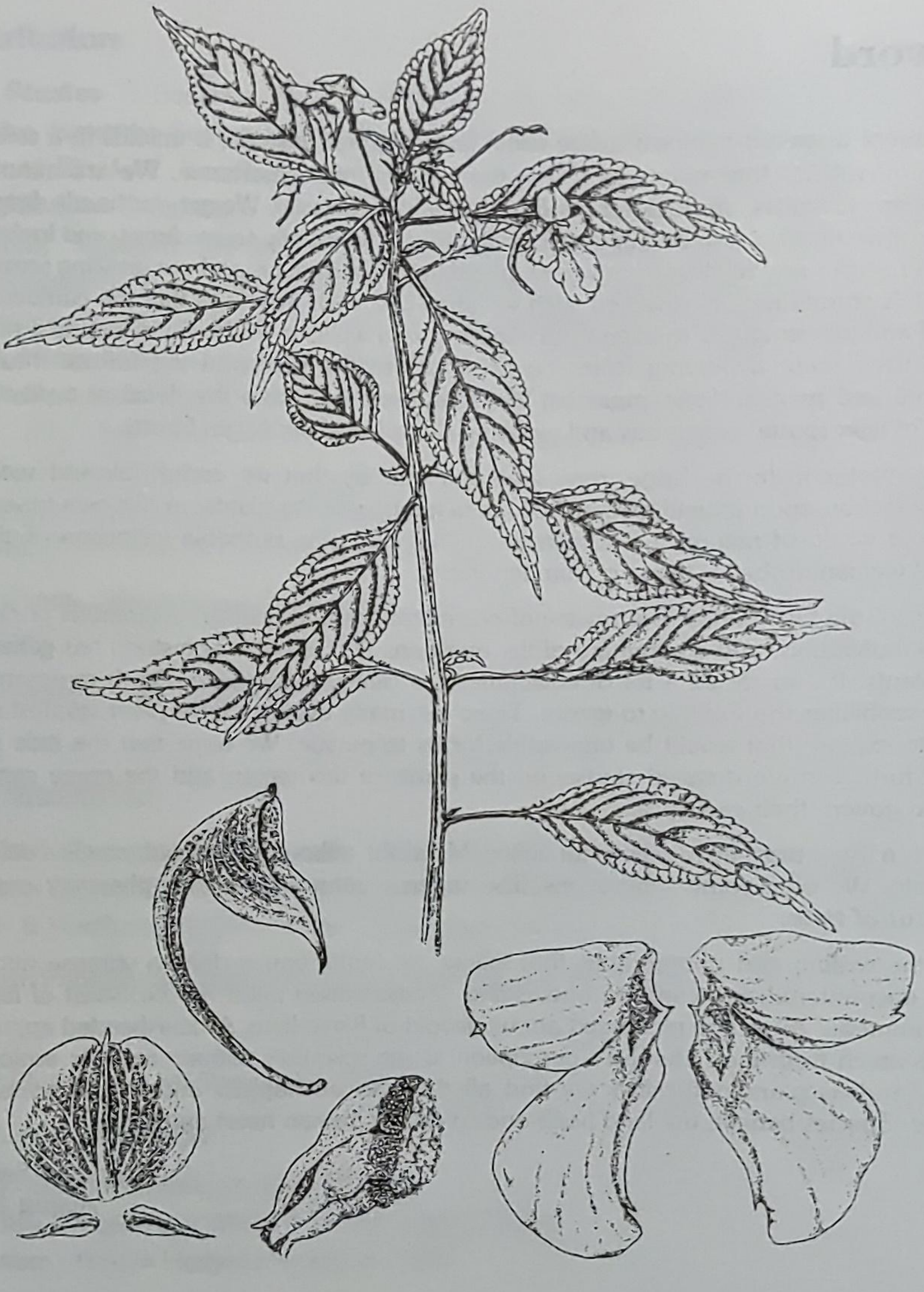
The essay 'Notes from the Edge' represents the journey that we undertook and seeks to provoke reflection upon individual connections to landscapes, to plants, to our own inherence in the wilder world of nature. In addition, it touches upon the probable extinction of all this and asks if we can do better than act from ignorance.

The 'Study of the Grasslands' is a review of our intentions and actions, a synthesis of reports by several individuals, and a summary of the questions that remain. The study has generated a list of plants. It also raised a lot of questions. It is clearly incomplete. But it represents an array of possibilities too exciting to ignore. There are many avenues for a plant scientist or an ecologist to explore that would be impossible for us to pursue. We hope that this little study will beget further, more detailed studies on the plants of this region and the many complex factors that govern their existence.

Tucked in is a list of recommendations for action. Mukurthi, although protected, needs a different kind of help. We offer some suggestions. The urgency cannot be overemphasized: ***we are running out of time.***

Through the writing and photographs that follow, we invite you to take a glimpse into the world we encountered and came to understand. Conservation need not be bereft of feeling and enchantment. An action plan need not be devoid of fierce love. A clear-headed approach benefits as much from the naturalist's description as the scientist's experiment. As ecological gardeners and as plant naturalists we find all these to be happily and even necessarily compatible. Species benefit, the land heals and so do the human heart and life.

Suprabha Seshan
August 2005



Impatiens leschenaultii

Endemic - Western Ghats

ESSAY: Notes from the Edge

Suprabha Seshan

Introduction

On a blustery, wet day in the monsoon of 2001, we ventured for the first time into Mukurthi National Park, thanks to Frederick Solomon, a remarkable individual in the Tamil Nadu Forest Department who was just about to retire as a Ranger of the Park. His love and knowledge of that landscape, its wildlife and its native plants, instantly encircled us and drew us in to a high hidden fold. That first encounter was spent in rapid-fire exchange of botanical trivia at the beautiful little orchidarium Solomon had created at Avalanche. This was followed by two heady, exhilarating trips to Bangitappal and Sispara.

Every time we met Solomon we badgered him with questions and observations. From a chance query – "*How pristine is Mukurthi?*" - dawned the realization that the plants of the Park and particularly of the grasslands, had not been systematically inventoried. Solomon suggested we conduct a study. In his wisdom, the Warden, Dr. Paul Raj, supported this. We made our proposal to the TNFD Headquarters which quickly granted permission. Meanwhile, Solomon retired, Dr. Raj was transferred and the new Warden, Mr. Ashok Upreti, inherited us – a ragtag crew of gardeners with grand and impassioned visions for his charge, the wondrous but beleaguered Mukurthi National Park.

Virtually overnight the project revolutionized our work in species conservation at the Gurukula Botanical Sanctuary in Wayanad. The study came about just when the GBS garden was bursting at the seams with rare native species ready to be turned out to larger areas, particularly to degraded habitats where these species are naturally found. The individual plants whose behaviours and progress we have observed on a daily basis over decades, and the wilder vaster landscapes and environments to which they belong, bracket a rich minefield of issues on two fronts: one involving time and the other involving space. Mukurthi National Park offered us a chance to grapple with the big side of things, big time and big space. From our 50 acre garden we were catapulted to a 77 square kilometre wilderness, a tropical mountain area brimming over with unimaginably beautiful plant species.

The first task was to reconnoiter the terrain at the height of the monsoon under constant cover of thick mist and chilling rain. Once this was done, the plant inventory began in earnest. Before

The Magic of Mukurthi

The rich swards with their island forests roll away in the pearly mists to drop suddenly without warning over vertiginous cliffs to the plains and plateaus of Kerala. To the north and west lies Wayanad, then Nilambur to the southwest, and Silent Valley and Attapadi to the south. This is a stunning country where overtowering edges meet quiet modulations. On a clear day we can take in almost all of Mukurthi in a glance, a seemingly vast and uninhabited land. With a single sweep your eyes can take in crest-lines, escarpments, deep drops, bumps and bosses, as well as cloven and sheer faces that run for miles upon miles. There are horizontal and vertical planes intersecting dramatically at the edge of the Park, showing us in plain relief that we stand on the edge of Horst or block mountains produced by the processes of faulting and subsidence or upliftment along fracture lines.

speculating about the state of the Park we needed to identify the species there. The TNFD recognized the importance of this and for two enchanted years gave us an unfettered run of this ethereal mountain realm.

Ecologies in Collision

Very soon we met head-on with a disquieting possibility: that the grasslands of Mukurthi might be deteriorating, even dying. How could we know this? The same way we know when any living thing starts to slump. We simply see it or sense it. If the signs are disturbing enough we consult the specialists. Ecosystem decay is the process whereby a patch of habitat, if it becomes too small and isolated, or too disturbed too frequently, or too choked with non-native species, starts to lose its own species, its capacity for self-sustenance and more significantly, for self-repair. A habitat can retain its full complement of species if it continues to receive immigrants from other habitats. This immigration and exchange of genetic material fosters health. Without this exchange, depleted or isolated populations lose vigour and give way to dominating or aggressive species (Wilson 2004).

However, the only immigration into MNP is of exotic species.

The fact that exotic plant species can be found in every valley of the Park is itself a sign of ill health. The fact that some native species are found in patches of less than 20 sq meters (and nowhere else on the planet) is highly worrying to plant conservationists like us. The fact that some species reported from the Upper Nilgiris are not to be found in *this* final refuge or anywhere else, is singularly alarming.

Despite the best of efforts, we worry that Mukurthi teeters on the terminal brink. Ecologists tell us that the collapse of a wild system may be gradual for a long period and then suddenly come to a point beyond which things just give up and buckle under the strain. No one can say precisely when, since ecosystems remain relatively mysterious. But it is unequivocally understood that, despite improvements in protection, most of the world's wild places (if not all of them) are further deteriorating from the combined effect of stresses on different fronts. Three of the most severe of these are: the spread of invasive exotic species (microorganisms, plants, fungi and animals), global climate change (with its highly unpredictable consequences) and habitat fragmentation (the attenuation of wilderness areas into small, isolated segments).

Tropical montane systems and the Arctic tundra are amongst the most vulnerable. They will most likely be the first to disappear as the climate warms. Cold-loving species will have no higher, cooler place to move to. Species from lower latitudes or elevations will move up as

Mukurthi is enchanting, despite the colonial travesty and the contemporary contradictions. Its soft rounded upland with edges that fall perplexingly away 1000 metres or more is exceptional in its beauty. Its vastness is beguiling: it appears to stretch unto infinity and yet you know it is a mere 77 square kilometres in size. You come to love the quickening in its wind and return again and again to be uplifted by its crisp clean air. Relatively few people come here, but those who do fall helplessly under its spell. This wild and graceful land, with all its invaded loveliness, its open wealds and staggering views, is surely a metaphor for the vanishing wildernesses of our homeland, like the other grassland forest systems of the Western Ghats.

temperatures rise. Where will temperate plants and animals go once they've reached the North Pole? Or if they are in the tropics, once they've fled to the tops and edges of mountains?

In other words, these systems *have their backs to the wall.* And of the southern montane grasslands of India, Mukurthi's condition may be all the more critical for historical reasons. Being smaller and more invaded by aggressive exotics, with a high percentage of endemics that are very vulnerable, the grasslands of Mukurthi may well succumb (perhaps to exotics, perhaps to sholas, perhaps to scrub, perhaps to lower elevation species) and they may well succumb soon. And the way things are going, *soon* could mean: *within our lifetime.*

In truth these tropical montane grasslands are flagship systems and hence the silent struggles of Mukurthi (and perhaps Eravikulam and Kudremukh) are both symbolic and real. Their decay represents the slow deaths of a million other places and their health is linked to the health of all. These systems generate and sustain the waters of our survival; they are composed of a fabulous array of plant forms that turn the mountains into giant orographic collectors of rain and mist and thus into the fountainheads of many of our rivers. Since they are also greatly pleasing to our aesthetic sensibilities they offer a chance to mitigate the colliding forces of global warming, habitat degradation and wanton despoliation: the broad range of unrestrained, often senseless activities that degrade and destroy the last of our wild spaces and habitats.

The Tragedy in the Beauty

As our mission was to examine this last natural refuge of the Nilgiris in terms of its rare plant communities, we needed to become very intimate with it. Over two years we spent some 250-person days walking every valley, fold, mound and cliff from Bangitappal to Sispara. We came to know its 200-odd grassland plants quite well and also its scarce and special animals. In all this exploring, there was one refrain that dogged our footsteps: this is possibly a dying wilderness, reeling under the collective and colossal effects of humanity. Yet because the area is awarded the highest degree of protection as a National Park, it is believed to be safe.

This is a dangerous belief and pure folly. Exotic invasives such as wattle do not respect a Park boundary. Nor do gorse and broom. Furthermore, this is not a problem that we can lay solely at the door of the Forest Department. The pressures on our wildernesses come from humanity's collective impact, from the insatiable demands we make on our environments. The folly lies in our failure to perceive how complex living systems operate under duress and in failing to correct our mistakes while we still have a chance.

July 2003

Cold mountain air with a special monsoonal edge numbs our faces and hands as we walk the many trails that wind along the valley bottoms or traverse the rounded hills. The meadows ripple with Hedyotis *flowers. Each of us appears and disappears like the rhododendron forms through the white silent mists of Mukurthi. We are challenged in so many ways to make sense of this complex and ancient terrain with its tiny flowers, heaving meadows, the presence of tiger, sambhar and tahr everywhere, its confusing histories. We have to juggle so many factors as we make our observations: the role of winter frost, the significance of fire, the wind, the hard biting heavy monsoon rain, the slope of the terrain and its aspect. We have to make our own tracks through all this despite the many studies that have been done here, despite the fact that the Nilgiris were one of the most botanized places in the tropics and there is very little that we can expect to find that will be new or different. Yet the silence and the slow rambling over many visits generate all kinds of surprising insights. We are aware that we walk in the footsteps of Gamble, Fyson and Wight, three of the botanical giants who worked in the south over 100 years ago. We are aware that these wildernesses have diminished hugely since their time. We are achingly aware that some*

There is neither rhyme nor reason as to why the great expanses of the Nilgiris have been so tragically reduced. A good part of the destruction seems utterly whimsical: our colonial forebears were homesick for the native plants of the British Isles and had no qualms in turning them loose upon the Nilgiri countryside. A good part of the transformation was deliberate: because the grasslands were perceived as *wastelands* they were planted up with "useful" exotic woody species like wattle, which have turned out, 50 years later, to be aggressive, invasive and destructive to the fragile and highly localized mountain ecologies. Furthermore, despite good intentions, no truly comprehensive conservation strategy has been developed for this rare and unusual environment. Our first and immediate concern is that we need to work quickly and well *together* if we hope to protect Mukurthi. We need to agree upon an approach that will improve the life of the various species that live there, be it the Nilgiri Tahr, or the Tiger or the Laughing Thrush or the last of the evanescent *Impatiens*. We need to think in terms of the whole *and* of the parts. The biosphere is, after all, a seamless interwoven skin: knit together by a prodigious variety of living creatures.

There are many cogent reasons why the world needs places free of exotics though that may well be an impossible task to achieve. Improved benefits to humanity are the least of those reasons. Better ones range from ecological to the aesthetic. Water, for instance, gurgles perennially out of these grasslands. The grasslands are truly a sponge, whereas wattle plantations tend to dry out the hill slopes while impoverishing them.

Moreover, we need to clear the exotics out of Mukurthi because they will soon make us forget what was there, that these southern mountains held life other than wattle, daisy and broom. Grassland with exclusively native species will give us perspective, first of all, on the difference between the untrammeled and the invaded. Perspective on the difference between wildness and trash. But for this we need to feel for ourselves, in some kind of fierce and absolute way, the utter importance of wild things and wild places. We need to regard them and treat them as sacrosanct.

We certainly cannot afford to lose any more time. The IUCN estimates that a fifth of all plant species may disappear in the next few decades. If indeed one out of every five plants could be extinct by 2030, what is our moral responsibility? Especially when we now know undeniably that the health of ecosystems, and therefore of humanity, comes from the wealth of species, from life-diversity. Southern India, with its environments already shattered and overburdened by the lives of its people, may lose its plants even sooner. And what sort of a life will *we* have without our plants and our forests?

plant species are so fragile they may disappear in our own lifetimes. Is there the smallest chance that we can make a difference? This is why we are here now: to find out if we, together with all our collaborators and colleagues, can nudge these communities towards greater health instead of untimely decay and death.

Our walks are always slow. There is so much to see, savour and puzzle over. Gardeners have a certain pace, a slow stride that lingers long on every other step. Mukurthi as we come to know it has the feel of a tapestry being woven with exquisite and meticulous care. There are multiple dimensions to connect, the wild present, the great spans of evolutionary time, the way plants are distributed not only here but across the entire Western Ghats. Little things intrigue us. For instance, the fact that the valerians are blooming profusely in one valley but not another. Or that Pimpinella, Andrographis *and* Senecio *seem to have flowered earlier than usual. Or that half the scapigerous* Impatiens *species on earth can be found within the boundaries of this Park and nowhere else. Or that* Alchemilla indica, *a gregarious herb forming thick mats in valley bottoms has its closest relative in the Himalayas. That, likewise,* Gentiana, Senecio, Rubus, Potentilla, *and* Geranium *are largely temperate genera.*

A Chance to Heal

The Mukurthi study has brought our little garden's work into a public sphere of action almost overnight. We are familiar with how plants work, how they behave, what they indicate. Most importantly, we know *what wonders some can do and what havoc others can wreak.*

Plants are the basis for all ecosystems: *any* high school student knows this. And yet, humankind's real awareness and appreciation of them, our once abundant knowledge of the power of plants, degenerates to pathetic levels, much to its own peril. We urge the stewards of the environment to work more closely with the plants. If anything, they can absorb the looming desolation of our era. If we work with the plants we may gain some time, we may stand some chance of reprieve. At the very least we may slow down the dreadful decay.

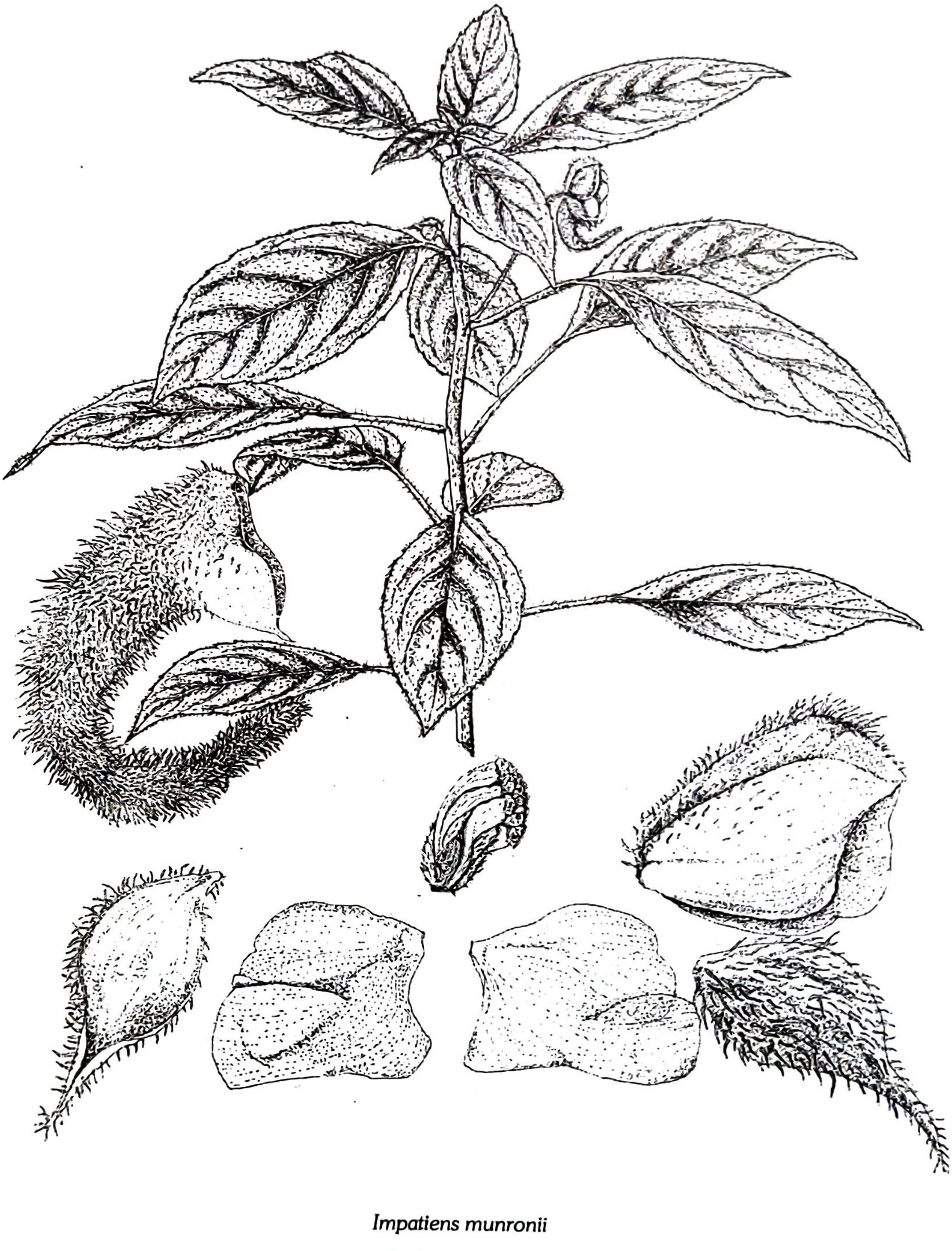
We have ideas on how the rare and fragile plant members of the Mukurthi uplands could be nudged to better futures and how the disturbed and degraded areas of the Park could be healed. These ideas have sprung up not only from our field trips and observations but also from our insights over 25 years into the plants of the Western Ghats, as well as the innumerable discussions with individuals similarly concerned and their insightful, practical and timely contributions to the issue, both in general and specifically. The timing for the study could not have been more perfect: it happened just as "restoration and rehabilitation" were entering the local environmental debate, just as environmentalists in India started waking up to the fact that exotic species are the biggest single threat to our native flora and therefore to our landscapes.

There is an enlightenment of sorts slowly happening. Whether it will evolve fast enough to spare our final refuges from the ravages of exotics and tourists, from further senseless plantations, from climate change and total ecosystem collapse really remains to be seen. It depends on every single one of us who would be ecological citizens, not merely onlookers and speculators, who are ready to act swiftly and accordingly.

This dawning of a new era took place in February 2005 at a meeting of the Ecological Restoration Alliance organized by our friends in the Palnis and Nilgiris and attended by the Forest Department in a terrific show of support. People are indeed starting to put their collective experience together and drafting a much-needed plan for the montane ecosystems of the Western Ghats. We are glad to be part of this and we hope beyond hope that good sense has finally dawned ....upon all of us.... and that it is not too late.

We find ourselves marveling at the ingenuity of grass - the positioning of meristematic tissue at the base of the leaf allowing for great generosity: a whole world of grazers and carnivores springing forth. Grasses, obviously, like to be eaten, burnt, and trampled upon! We find ourselves pondering upon the Toda and Badaga graziers and their several thousand head of cattle, all the dung and urine that must have charged this place for millennia and the consequences of their removal. We observe bees in the mist, buzzing from flower to flower, and realize that entire lives are lived in the cold and the wet and the wind and the biting rain....that entire mountainsides of Impatiens *flowering in the peak of the monsoon must get their pollinations done by very tough (and very waterproof) beings.*

The heterogeneity of the ecosystem has to be experienced on foot. We must explore that spur and that ridge and that mound and that hollow. As we turn around a grassy knoll, we discover an unbelievable expanse. More angles, different perspectives. Huge spaces. Wildness incarnate. Woods nestled on other cliffs, facing other directions, overlooking valleys that open southwards, the Bhavani puzha tumbling way below. We learn that southwards implies something significantly different from westwards. There are other presences here, other goings-on, other spaces.



Impatiens munronii

Endemic-Nilgiris

STUDY: The Grasslands of Mukurthi

T. Sandilya, Suprabha Seshan, Wolfgang Theuerkauf

Introduction

In 2001 we made a proposal to the Tamil Nadu Forest Department for the survey, rapid assessment and restoration of vegetation diversity within Mukurthi National Park. Our goal was the long term conservation of rare and endemic plant species and native plant communities. The proposal was based on our own work on species conservation, rehabilitation, and ecosystem restoration at the Gurukula Botanical Sanctuary.

Concerns

National Parks contain some of the most pristine of India's natural habitats and are also the best protected. However, some Parks are relatively young in age (10-20 years) and were interfered with or intensively managed during the 50 to 100 years prior to notification. These activities have had a significant impact on the populations of native plant species. In addition, National Parks include only a small fraction of the area in which they are situated, and are susceptible to species erosion due to overgrazing from high herbivore concentrations, or climate change. Mukurthi National Park, which came into existence in the early 1990's as an area of great natural beauty and wildlife value, has significant areas under pine and wattle, the planting of which may have impacted the diversity and richness of native plant communities.

Our study was aimed at establishing guidelines for assessing the floristic health of the ecosystem. The Upper Nilgiris in the south western areas of the range, 77 square kilometres of which are protected under the National Park, contain some of the most pristine, least disturbed natural ecosystems in the Western Ghats. They offer an opportunity to examine the gradation from healthy, somewhat intact plant communities, to poorer or degraded ones. They also offer ideas for the restoration of altered areas to conditions of ecological 'health' and the process towards natural climax. This is particularly important in landscapes where habitat destruction is high. The fragmentation of natural areas into unsustainable pockets of diversity is one of the biggest crises of our times and is the current focus of the huge interdisciplinary effort that is 'restoration ecology'.

Our first visits to Bangitappal had raised concerns. Although the study area is protected by its National Park status, it has been worked in the past. One of the first approach roads to Ooty from the Kerala coast was built through this land. The effects of colonial experiments in afforestation using wattle and pine are still to be seen. As the climate is harsh at the south western edge of the Nilgiri plateau, the wattle failed to survive and all that remains of the vast plantations made between the 1920's and 1960's are scattered saplings and rows of empty holes in a few places. These grasslands must have been affected by other factors too. The combination of road-cutting, pitting, the gradual spread of exotics, fires and building work would have caused disturbance to the grassland ecology, not to mention the effects of habitat fragmentation and climate change.

STUDY: The Grasslands of Mukurthi

T. Sandilya, Suprabha Seshan, Wolfgang Theuerkauf

Introduction

In 2001 we made a proposal to the Tamil Nadu Forest Department for the survey, rapid assessment and restoration of vegetation diversity within Mukurthi National Park. Our goal was the long term conservation of rare and endemic plant species and native plant communities. The proposal was based on our own work on species conservation, rehabilitation, and ecosystem restoration at the Gurukula Botanical Sanctuary.

Concerns

National Parks contain some of the most pristine of India's natural habitats and are also the best protected. However, some Parks are relatively young in age (10-20 years) and were interfered with or intensively managed during the 50 to 100 years prior to notification. These activities have had a significant impact on the populations of native plant species. In addition, National Parks include only a small fraction of the area in which they are situated, and are susceptible to species erosion due to overgrazing from high herbivore concentrations, or climate change. Mukurthi National Park, which came into existence in the early 1990's as an area of great natural beauty and wildlife value, has significant areas under pine and wattle, the planting of which may have impacted the diversity and richness of native plant communities.

Our study was aimed at establishing guidelines for assessing the floristic health of the ecosystem. The Upper Nilgiris in the south western areas of the range, 77 square kilometres of which are protected under the National Park, contain some of the most pristine, least disturbed natural ecosystems in the Western Ghats. They offer an opportunity to examine the gradation from healthy, somewhat intact plant communities, to poorer or degraded ones. They also offer ideas for the restoration of altered areas to conditions of ecological 'health' and the process towards natural climax. This is particularly important in landscapes where habitat destruction is high. The fragmentation of natural areas into unsustainable pockets of diversity is one of the biggest crises of our times and is the current focus of the huge interdisciplinary effort that is 'restoration ecology'.

Our first visits to Bangitappal had raised concerns. Although the study area is protected by its National Park status, it has been worked in the past. One of the first approach roads to Ooty from the Kerala coast was built through this land. The effects of colonial experiments in afforestation using wattle and pine are still to be seen. As the climate is harsh at the south western edge of the Nilgiri plateau, the wattle failed to survive and all that remains of the vast plantations made between the 1920's and 1960's are scattered saplings and rows of empty holes in a few places. These grasslands must have been affected by other factors too. The combination of road-cutting, pitting, the gradual spread of exotics, fires and building work would have caused disturbance to the grassland ecology, not to mention the effects of habitat fragmentation and climate change.

Aims

First we wished to try and establish whether or not there had been a change in the composition of plant species in the study area and its surroundings over the course of the last, say, 200 years. The Nilgiris have been a hotspot for botanists since early colonial times and the Mukurthi National Park area in particular has been well studied. References to Sispara, Nadugani and Bangithappal would help us to build a picture of how the grassland flora may have changed. Species common in the past may have become rare. Some may have disappeared altogether. Frequent fires followed by cattle grazing by Todas may have made it possible for exotic weedy species to take hold. The grazing by Toda buffaloes may also have had a significant impact on plant community structure and composition.

The second aim was to conduct a detailed inventory and analysis of the current state of the grassland community. This would be valuable on several counts. Many of our tropical montane plants are highly localized and the Upper Nilgiris are particularly rich in narrow endemics. In order to conserve them it is therefore crucial to understand the habitat preferences and distribution patterns within the areas where they are found. In addition, the grassland community (along with the shola) is itself an unusual and fragile ecosystem, and a highly endangered one. It is imperative to allow for the return of this system in degraded and fringe areas or even in other parts of the landscape, using an integrated approach of species rehabilitation, restoration, active intervention and changes in rangeland management.

The overarching goal was to help the Forest Department prepare a detailed conservation action plan for the Park with the plant community in mind. By working out the gradient from pristine to degraded parts of the ecosystem, surmising the possible factors for degradation, and establishing a historical thumb rule for comparison, we hoped to provide a sound basis for proactive conservation strategies. In particular, we hoped to develop an ecological benchmark to which degraded areas can be restored or encouraged and thereby increase areas under natural ecosystem processes and assemblages.

A long term view of the Park, we propose, must be inclusive of plant species. Holistic approaches to habitat restoration, including the reintroduction of native herbaceous plants, are still in their infancy, although reforestation with native trees has been widely practiced. Crafting a habitat together, with its myriad member groups of mosses, ferns, grasses, legumes, orchids and impatiens has not, to our knowledge, been attempted in a systematic way. In addition, flora ranging over the various different life forms (epiphyte, climber, herbaceous terrestrial, woody terrestial, woody monocot, etc.), have not been used in restoration work, especially in complex systems.

This may be because most wild plants, especially herbaceous ones, are difficult to establish as they tend to be very specialized in their ecological preferences. Arboreal species may be choosy, but herbaceous flora are much more so. Since most tropical plant communities have a high herbaceous component it is essential to find holistic measures for habitat restoration. New techniques must be developed for the restoration of complex and threatened communities, and the trials at Mukurthi National Park are a pioneering contribution to this field, requiring monitoring over many years to understand the scope and progress of the restoration.

Objectives

Our initial objective was to survey and make an inventory of the existing plant diversity of the grassland areas and compare the current state with data from archival records. A thorough survey of the vegetation of the Mukurthi grasslands had not really been done (with the exception of 88 species recorded in Dr. Murugan's *Phytosciological Changes of Shola and Grassland Ecosystems due to Human Interference*) and would be valuable for its own sake. The steps of our first phase were:

- Assessment of the vegetation diversity of the grasslands between Bangitappal and Sispara
- Mapping areas of high biodiversity value
- Comparing and contrasting areas that have never been interfered with, with those that have been planted, cleared or managed in some form.
- Identifying plant populations and habitats that appeared unhealthy, 'depleted' or unviable within the Park
- Archival research of foresters, botanists, explorers and residents of the Nilgiris to extract data on plant diversity during the past century

  In a second phase, we hoped to design a plan of action for restoring, if necessary, native plant populations to conditions of viability. This would include:

- Creation of a native plant restoration programme on the basis of study findings, possibly including protection from fire and grazing, seed scattering, relocating mature individuals within the Park, phasing out exotics, etc.
- Identifying Nilgiri plant populations outside the National Park that may be under threat of destruction.
- Beginning planting schemes including rehabilitation of populations from unprotected areas in other parts of the Nilgiris, or from plants propagated through ex-situ conservation methods at the Gurukula Botanical Sanctuary. In highly degraded areas, one should mimick the natural successional processes in planting, to allow conditions and niches to build up for more specialized species.

Field Work

A team from the Gurukula Botanical Sanctuary made field visits of 7-10 days every 4-6 weeks (depending on the season) between August 2002 and August 2003. Initial visits were conducted with the help of the forest department staff. GPS points were taken along all routes across the study area. In the second year, visits averaged four days every two months. A total of 250 person days has been spent in MNP.

Over the two years we became very familiar with the area between Bangitappal and Sispara, and our walks eventually covered every valley and hilltop. Although we generally kept to the trails, there were many valleys where we went off-trail to see interesting plants, guided by intuition and experience. We did our field work in all weather conditions. A great number of the grassland species are annuals appearing only in the monsoon, hence we had to work in this season in full rain and under heavy mist. The dry season is sparse in flowers but we were able to cover large distances and to get to know the place very well. Between field visits the team also engaged in archival research and examination of the data gathered. In the second year material from other sources was compiled and experts on grasslands and grassland species were consulted. The list was added to and revised using several floras. Discussions on the 'exotic factor' and 'ecosystem decay' dominated most of our consultations.

Supplementary Research

Archival Visits: We travelled to Chennai in January 2003 to find historical information on the area between Bangitappal and Sispara. We visited the Connemara library and the library of the Forest Department (where we obtained a copy of T. R. Ranganathan's Working Plans for the area). At the Tamil Nadu Archives, we were only able to process the permission for access so research will be done at a later date. We have also been told that P.F Fyson's diaries are kept at The Presidency College, where he was Director during the writing of The Flora of The South Indian Hill Stations.

Consultations: In December 2002, we visited the study area with members of Ashoka Trust for Research in Environment and Ecology and Foundation for Ecological Security in order to establish a research protocol for the field work. We spent two days walking over Madippumala, Nadugani and Sispara areas and discussed our collective observations. We all agreed that the main disturbances in the area were wattle and fire and that both could affect floral diversity. In areas with low intensity burns, diversity was possibly enhanced. We then agreed to set up some experiments (if the study were to continue) to establish quantitative data that would enable us to compare the effects of these disturbances. Plots could be marked out along two gradients to start with, across areas with different densities of wattle, fire frequencies and compared with areas that we know to be relatively undisturbed.

Flora of the Study Area

T. Sandilya

Grassland Types

The grasslands can be categorized visually by the following characteristics:

Dense grassland, tall or short, where there is no exposed ground. This kind of grassland can be quite rich to very poor in diversity, both in grasses (*Themeda tremula*, *A. lividus* and *Eulalea phaeothrix*) and other herbs. There is one species of grass found on most of these areas (*Dicanthium polyptychus*), and in some places, especially at the base of hills where it is sheltered, this particular species grows very densely. In such areas, the grass cover is very long and dense and almost completely dominated by this one species of grass, allowing no other grasses or herbs to grow there. Flat areas near streams that are not waterlogged have another dominant species of grass that is also tall and dense with hardly any other plant growing among them (*Chrysopogon zeylanicus* and *Helictotrichon virescens).* Such grasslands are found only in a few places covering small areas. In places where dense grass is short, usually there is a high degree of exposure to wind. These areas are diverse in grasses and other herbs.

Patchy grassland, tall or short or both, with varying degrees of exposed ground. Most of these grasslands show signs of burning. Some of these areas range from being very diverse (Nadugani), to very poor (Kingerundi area where there is a lot of exposed ground probably due to excessive burning). Hilltops have patchy grassland with or without evidence of fire.

Dense grassland and patchy grassland have many species of plants in common. Some examples are: *Leucas suffruticosa, Anaphalis wightiana, Andrographis lobelioides, Impatiens diversifolia, Swertia corymbosa and Smithia blanda.*

Shrub-dominated grassland, where different species of shrubs are dominating an area. Examples of shrubs that do this are: *Strobilanthes kuntianus, Strobilanthes wightianus, Hedyotis stylosa, Hedyotis articularis, Anaphalis neelgheriana, Helichrysum wightii, Helichrysum buddleoides, Gaultheria fragrantissima, Eurya nitida* and *Rhodomyrtus tomentosa.*

The most common and widespread shrubs are *Strobilanthes kuntianus*, which is growing abundantly around Nadugani and Kingerundi area, and *Strobilanthes wightianus* which is found in most of the valleys, growing very densely along the streams. All the other shrubs are less widespread and are not found in such large numbers. *Helichrysum wighti* is found only in a few places, and *Gaultheria fragrantissima* is found as small clumps all over the area.

Herb- dominated grassland, where different species of herbs are dominating an area. Examples of dominating herbs are: *Pteridium aquilinum, Hedyotis verticillaris* and *Alchemilla indica.* The most common and widespread of these herbs is *Pteridium aquilinum* which can be seen growing in scattered clumps of different sizes, on almost all the slopes. *Hedyotis verticillaris* is found mostly on wet places in the valleys, in small clumps to large masses. *Alchemilla indica* is growing only in two places: the Bangitappal valley near the guesthouse and on the way to Nadugani near the "labour shed."

Rocky grassland, where grasses and other herbs grow on or among rocks and boulders. Many of the hillsides have large rock faces sometimes covering the whole slope. They may be a single face or jagged. Boulders are found clumped on top of a few hills. Some of the grasses *(Garnottia puchiparensis, Chrysopogon asper* and *Agrostis stolonifera*) and herbs found in rocky grassland are not found in other types of grasslands. Some examples of herbs are *Pedicularis perrottettii and Impatiens acaulis. Eupatorium glandulosum* can be found throughout the area on disturbed soils. Pine is planted very densely in at least four places, each plantation being around 5 acres. One is in the Bangitappal valley, and the others in different places along the approach road. There are also several exotic herbs growing in the area. Two examples are, *Calceolaria mexicana* which is spreading around the buildings of Bangitappal and *Erigeron mucronatum* which is spreading on many of the hills. Exotic grasses are found in small populations only, and mainly in the Bangitappal area. They are *Brachipodium sylvaticum* and *Anthoxanthum odoratum*.

Leucas rosemarinifolia and epilithic orchids such as *Aerides crispa* and *Ceologyne glandulosa* are found here.

Marshy grassland near streams or before the starting of streams. These are usually quite small and diverse and have some species of plants that are special to this type of grassland like *Impatiens rufescens, Parnassia wightiana, Senecio wighti and Juncus glaucus*

Shola-edge grassland

Some plants can be found only along the periphery of sholas, common examples are *Impatiens leschenaultii, Helichrysum buddleoides, Senecio intermedius* and *Rubus ellipticus.* Grasses such as *Ischaemum commutatum, Agrostis pilosula* and *Isachne kunthiana* are found here.

Common Families	**Common Species**	**Rare Species**
Acanthaceae	Anaphalis wightiana	Anaphalis leptophylla
Asteraceae	Erigeron mucronatum	A. notonia
Balsaminaceae	Eupatorium glandulosum	A. fysonii
Cyperaceae	Hedyotis stylosa	Centratherum reticulatum
Eriocaulaceae	H. articularis	Crotalaria formosa
Poaceae	Helichrysum buddleoides	Geranium nepalense
Lamiaceae	Impatiens clavicornu	Habenaria barnesii
Melastomataceae	I. diversifolia	Habenaria pallidiviridis
Orchidaceae	Justicia simplex	Hypericum hookerianum
Papilionaceae	Leucas suffruticosa	Impatiens rufescens
Rubiaceae	Pteridium aquilinum	Kalanchoe grandiflora
	Rubus mollucana	Pedicularis perottetti
	R. neveus	Picris hieracioides
	Senecio lavandulifolius	Pimpinella leschenaultii
	Smithia blanda	Plectranthus barbatus
	S. kunthianus	Pogostemon atropurpureum
	S. wightianus	P. mollis
		P. speciosus
		R. subpinnatus
		Senecio lawsonii
		S. lessingianus
		Sonerila grandiflora
		S. rotundifolia
		Striga lutea
		Wahlenbergia gracilis

Plant profile within study area

Anthropogenic Factors affecting the Flora

T. Sandilya, Suprabha Seshan, Bob Stewart, Tanya Balcar

The grasslands have been affected by human activities in several ways: by the presence of exotics, by problematic native species, by fire and through construction and tourism.

Presence of Exotics

In addition to Wattle, major exotics in the area include Broom *(Cytisus scoparius)* and Gorse *(Ulex europaeus)* which is spreading on the hills along the approach road, and above the Earthen Dam along the road going to

Wattle *(Acacia dealbata, mollissima and mearnsii)*

Wattle is found in roughly half the study area. The north and northeastern hills have the most number of wattle trees with very dense full-grown plantations. All the far eastern hills have wattle cover of different densities. Towards the west and south they get smaller and less dense. Scattered wattle saplings are found up to the edge of the plateau. The only place that has dense wattle within the core areas of this region is below the south face of Madippumalai, where they are sheltered from the east and west by Madippumalai's side ridges. There are a few small dense clumps there, and the rest of the hills have scattered medium-sized trees. Places with high wind exposure (along the edge of the plateau, top of Madippumalai) have many dead saplings and the ones that are alive are very small and stunted. No full-grown trees are seen anywhere except on the northeastern hills. The spread of wattle comes to a halt towards the south near Bhavanipuzha bridge on the way to Nadugani. The extent of the area where the wattle has been planted is shown in M. Thyagarajan's *Working Plan for the Nilgiris Forest Division*.

In areas with sparse wattle cover, there is no apparent difference between grasslands with and without wattle, in terms of texture or species diversity. But this will have to be established with careful study.

The Forest Department has been eradicating around 20 to 30 ha of wattle every winter for the past five years on the northeastern hills – close to the approach road. These are mostly areas that have scattered, full grown trees. Trees have not been cut where the growth is very dense. The eradication is not entirely successful. Many of the stumps are sprouting new shoots and new saplings can be seen. Many of the trees cut are already dead. The cut trees are left where they fall and they are often covered in Bramble *(Rubus moluccana).* There has been an attempt to plant native shola trees on a few of these wattle-eradicated slopes by digging large holes. Almost none of these saplings have survived.

Pitting done across the whole landscape till Nadugani, for the planting of wattle, seems to have left little obvious effect. But how would we know unless we were able, in some way, to construct a scenario of the grassland flora prior to the 1920s? It was done on a large enough scale that at the time it would have constituted a significant disturbance, especially for delicate grassland species. It would also have made it possible for seeds of exotics to take root.

Acacia mearnsii

Prior to the study, during March 2000 and September 2001, we had not noted invasion by this species in the area between the ghat and the rest house. Now there are thousands of saplings established between the ghat and the large pine plantation. The road appears to be an important conduit while the species prefers the better-drained areas of the grasslands. Seed banks were provided by an old plantation at the lower dam site and some mother trees at the quarry site on the ghat road.

Most of the saplings are not yet producing seed and timely intervention can prevent this invasion from becoming an intractable problem. *Acacia mearnsii* can be killed if it is cut hard to the base.

Towards Nadugani this species is scattered over hillsides for several kilometres. It seems that this *Acacia* is not happy here; nevertheless the seedlings present need to be monitored carefully as a window of opportunity (climate) may occur that favours the species. We have no explanation for the relative health of the species at Bangitappal compared to here, except that the area may be better drained.

Acacia melanoxylon (Blade leaf)

This tree thrives at Upper Bhavani but the planted trees on the Bangitappal ghat road are miserable and only a few saplings are evident as regeneration. On the other hand towards Nadugani there are hundreds (possibly thousands) of seedlings in the grassland. We do not know whether their presence is recent or long term. There are no mother trees to account for their presence.

Ageratina adenothera (Eupatorium)

This species can be enormously invasive. Here the plants appear to be weak, but nevertheless ready to occupy any disturbance in the grassland. These can be easily uprooted without serious disturbance while removing other exotics.

Cytisus scoparius (Broom)

This plant has seriously invaded other areas in and around Mukurthi National Park. It is spreading from Avalanche – Upper Bhavani along the road to the Bangitappal rest house. Seed carried by vehicles (in mud) is the likely cause. Elsewhere Sambar deers grazing preference for the plant makes it the major vector for seed. In Bangitapal the invasion is still fairly light and can be controlled while other eradications (*Acacia*) are in progress.

Erigeron mucronatum

This sometimes dominant mat forming species is found almost everywhere and appears to be spreading. A study of the ecology and dynamics of this species is highly recommended.

Ulex europeus

A large clump off the Nadugani path, one kilometre from the rest house was observed but it was not seen elsewhere in Bangitappal.

Pteridium aquilinum (Bracken) is not strictly speaking an exotic (as its origin is unknown), but rather a pan-global species of significance due to its extremely tenacious nature. It is also usually an indicator of continuous disturbance. It shows a place to be in arrested succession. It is both pioneering and persistent and is not tolerant of other species. Grazers dislike it. MNP has patches of bracken scattered in several zones. What is the significance of this?

Problematic Native Species

Rhododendron arboreum ssp. *nilagiricum*

Although a native, this grassland tree is having a transforming effect especially in Bangitapal. The tree is a quick coloniser of disturbed ground. Bangitapal has experienced a whole variety of soil disturbance, road building, dam and rest house construction and pit digging for failed *Acacia* planting. There are several hundred young *Rhododendron* in the area whereas in less disturbed areas you can see large, ancient, lone trees without any saplings around them. Once the tree is established it provides cover for true Shola species to become established. The trees *Daphniphyllum neilgherrense* and *Eurya nitida* are the favourites. This transformation appears to be relatively recent as there are few ancient trees and many young ones. Pristine grassland appears relatively resistant to invasion so disturbance of these areas should be studiously avoided.

Rubus fairholmianus

This species of the wayside and Shola border is a newly emerging threat to the grassland ecosystem. Even where exotic saplings are 'unhappily' established they appear to encourage the establishment of this species. This may be because they provide perches for birds that then deposit seed. On the ghat we noticed the species was fire resistant, re-emerging after fire (March) while the *Acacia* nurse trees were mostly killed. The establishment of *R. fairholmianus* is widespread throughout Bangitapal. The tangled mass of this plant at the lower dam site is a harbinger of the future if it is not controlled. This would also require removal of the nurse trees.

Fire

T. Sandilya, Suprabha Seshan, Ankila Hiremath

Fire was an important factor affecting the grasslands even before the British arrived. The grasslands were burned to provide fresh fodder for both domestic animals and wild game, as grass sprouts well after a fire. Stretches between Bangitappal and Sispara have been burned within the last ten years, signs of which can be seen on tree stumps or grass clumps. Some areas, where it is known that fire has occurred, are very rich in diversity, and the two may well be correlated. Some of the hills that do not burn due to natural barriers have very tall dense grass and are poor in diversity.

Fire, at the right intensities and intervals, may be a positive disturbance in the ecosystem in terms of promoting higher species diversity. Wherever we could infer that fire had occurred in the past 1-3 years, species diversity appeared to be high. Where no fire had recently occurred the grassland was generally characterised by one or two dominant species of large grass and a paucity of other herbaceous plants. Again, this needs to be verified with controlled experiments or by establishing a fire history of the study area from which a quantitative sampling analysis could be made.

There are various lines of evidence about the role of fire (and other factors) in the maintenance of tropical montane grassland-forest mosaics. We have yet to find specific references to the role of (and need for) fire in sholas, hence one is forced to speculate and draw on evidence from elsewhere. The grass <-> fire feedback is thought to underlie the widespread occurrence of the grassland-forest mosaics characteristic of many mountainous areas in the tropics. These mosaics are maintained by frost (Meher-Homji 1967), periodic drought (Wesche 2003), fires resulting from human activity (Ellenberg 1979, Corlett 1987), or interactions among them. Human activity is not a requisite for all such mosaics, as evidence of those in southern India goes back to at least the last glacial maximum, a period of widespread aridity (Sukumar et al. 1993) and a time well before any evidence of people in these areas (Misra 2001).

Historical Information

Diba Sidiqqi, T. Sandilya, Wolfgang Theuerkauf

Forest Policies in the Nilgiris

In order to understand the prevalence and distribution of plant species in the Nilgiri grasslands over time we consulted a number of historical sources: *Working Plans* of the Forest Department for the Nilgiris Division, past volumes of *Indian Forester* (1874-1960) and papers on forest policy. Detailed botanical information about the locales and circumstances of plant species is rare. In the thousands of articles we scanned from *Indian Forester*, we found only three articles containing plant lists from the Nilgiris (in 1876, 1888 and 1959).

The main sources of information regarding the locations of species seem to be the plant floras assembled in the early twentieth century. Our perusal of limited sources presented material and perspectives about a host of themes: Fire, Grazing, Climate, Forest Policy, Plantations, Animal Behaviour, Entomology. Briefly presented here is an overview of the plight of evergreen woods (sholas) in the Nilgiris, the genesis of plantations and the forestry approaches of certain prominent Forest Department officials in South India.

The shola-grassland mosaic consists of clumps of montane forests nestled amongst undulating grassy hills. Both sholas and grasslands are rich repositories of diverse plant species. Hill communities have harvested firewood from sholas and grazed their animals in the grasslands for centuries. The first indiscriminate felling of sholas came with the establishment of British settlements in Ooty, Coonoor and Wellington in the early 1800s when sholas around these areas became the source of firewood for a growing population. Recognising the need to protect sholas, a "timber conservancy" system was established from 1841 onwards, whereby authorities would issue contracts to individual bidders to fell wood from identified sholas (Sutton, p.1). By this time, however, many sholas in the vicinity of the settlements had already disappeared and the conservancy measures were not adequately enforced. Commissioner of the Hills, James Breeks, wrote in 1868 "...unless conservancy is taken in hand and organised under the efficient control of an experienced officer, the destruction of the sholas is but a question of time." (Thyagarajan, p.70).

Around the same time that sholas were vanishing, a plantation culture was on the rise in the Nilgiris. Australian exotics were introduced between 1840 and 1856. These included four Acacia species: *Acacia dealbata* (silver wattle), *Acacia mollissima* (black wattle), *Acacia decurrens* (green wattle) and *Acacia melanoxylon* (blackwood), all commonly referred to as "wattle", and *Euclayptus globulus* or "blue gum". The hope was that these plantations would meet the fuelwood and timber needs of the area. Wattle proved to have poor timber value and compared unfavourably with Eucalyptus as a fuelwood source. *Acacia dealbata*, with its ability to spread rapidly by root sucker, colonised vast areas and was declared a pest. It was considered "useful for covering wastelands" (T.Jeyadev, p.12). *Acacia mollissima* plantations were maintained as the bark of the tree yielded tannin for the leather industry. By the mid-1860s *Eucalyptus* was favoured over *Acacia* species as a plantation tree.

C.R. Ranganathan, Deputy Conservator of Forests (1938 to 1948), refers to a fire-protection scheme proposed in 1920 by Mr. Tireman in the Kundahs, in which the Mukurthi study area lies. Tireman felt that the protection of sholas alone was not sufficient for the area and suggested that 10-15 acre plots be "planted up each year in places where sholas have almost or quite disappeared, the most suitable species probably being *Acacia dealbata*" (Ranganathan, p.84). Grasslands, a habitat replete with diverse species, were percieved as 'wastelands', only fit to be covered with *Acacia dealbata*.

R.H. Beddome, J.S.Gamble and Dietrich Brandis, senior forest officials from the mid to late 1800s, wrote definitive volumes on Indian ferns, flora and trees. Their works continue to be the main references for plant lovers. Their vast and intimate knowledge of plant species did not immediately translate into a plan for protecting plant habitats. Rather, in their roles as Conservators of Forests (Beddome and Gamble) and as Inspector General of Forests (Brandis) they organised the establishment and protection of plantations in shola-grassland country in the Nilgiris. Beddome was a proponent of eucalyptus plantations in the 1860s and 1870s. He advocated the planting of exotics in felled sholas, holding that native shola trees would take "at least a century to grow" (Sutton, p.3). In 1882, Brandis "recommended bringing present 1200 acres of plantation up to 5000 acres to create enormous forest blocks... which would make any remaining sholas redundant forest resources" (Sutton, p.6). In 1888 the Madras Government had protected 52 specific sholas in the Nilgiris from being used for economic gain. Gamble held that this was a "wasteful" policy and was instrumental in paring down the list to

9 sholas, all in the vicinity of the three principal settlements (Sutton, p.8). Writing in 1903, Gamble held that a forester "has to prepare his plan of working which is to last for many years and provide for the yearly utilization on the interest on the capital stock and the progressive improvement of the capital" (Indian Forester, Volume 29, p.494).

Unlike the conservation efforts of the present, which seek to ensure the long-term survival of the natural world, forest conservancy measures in India from the mid-1800s onwards were born out of a "necessity for the maintenance and conservative treatment of forests" (Indian Forester, Volume 19, p.260). The priorities of forest officials lay in replacing the earlier wanton felling of forests to the "working" of forests in a systematic fashion that assured the presence of forests as a continuing economic resource.

Toda and Badaga Grazing Patterns

For the Todas, the western edge of the Kundahs, in particular the Bangitappal area, was considered the site of the afterworld, and so unsuitable for settlements. However, it is known that they took their cattle there for summer pastures and we can conjecture that perhaps several hundred head of cattle were taken to the western areas. The effect of grazing on grasslands is well known. Diversity patterns are significantly altered with the number and type of grazers. The addition of cattle dung and urine would have surely affected the growth of plants along with the pressure from grazing and trampling.

Botanical History

Since the settlement of the area by the British in the early 19th century, the flora of the Nilgiris has been well researched and documented. In fact, for that period, the Nilgiris were probably one of the most carefully botanized places in the tropics. Many of the 19th century botanical giants have worked here: Beddome, Wight and Bourne, followed later by Fyson and Gamble. This gives us an unequalled picture of the flora of the Nilgiris before major human interventions occurred.

Although these early botanists were thorough field workers and taxonomists they left little data on plant ecology, few notes with exact distributions or locale information. To build up a detailed image of an area in terms of plant communities is therefore quite difficult, especially at the resolution we require. But the notes that do exist are invaluable, and the purpose of this study is to unearth their casual observations and annotations, and to compare past lists with our own observations. Much more exhaustive work needs to be done on this front, but the beginnings have been fascinating.

Given below is a list of a few species whose botanical history we were able to trace so far.

Species Found Then & Now

Impatiens clavicornu Endemic to the Nilgiris. In his *Icones Plantarum Indiae Orientalis*, Wight calls it 'a very beautiful and unusual form of balsam' which he had observed all over the upper ranges of the Nilgiris. Nowadays its distribution is exclusively restricted to the south-western edge of the Nilgiris, with the centre of distribution within the Mukurthi National Park.

Impatiens laticornis Endemic to the Nilgiris. In the Kew Bulletin 1930 Fisher calls it a common species in the Kundahs. It still grows abundantly in the National Park.

Impatiens rufescens Endemic to the Nilgiris. Wight calls it frequent in swampy grounds. At present only a few isolated populations are observed.

Crotalaria formosa Endemic to the Nilgiris. Wight says it is it frequent on the hillsides. In the present survey it was found only in a few spots.

Hedyotis verticillaris Endemic to the Nilgiris. This species was observed by Wight, Fyson and Gamble to grow abundantly in wet areas from Pykara to Sispara. At present the species is restricted to the area from Avalanchi to Sispara.

Anaphalis notonia In his *Icones Plantarum* Wight considers this to be a rare species. Only a few specimens were found in the present survey.

Helichrysum wightii Wight, Hooker, Fyson and Gamble report the species in dense masses from Sispara area. It can still be seen growing abundantly in the same area.

Andrographis lobelioides Endemic to the Nilgiris. Is reported by workers as common and can be observed frequently in the research area.

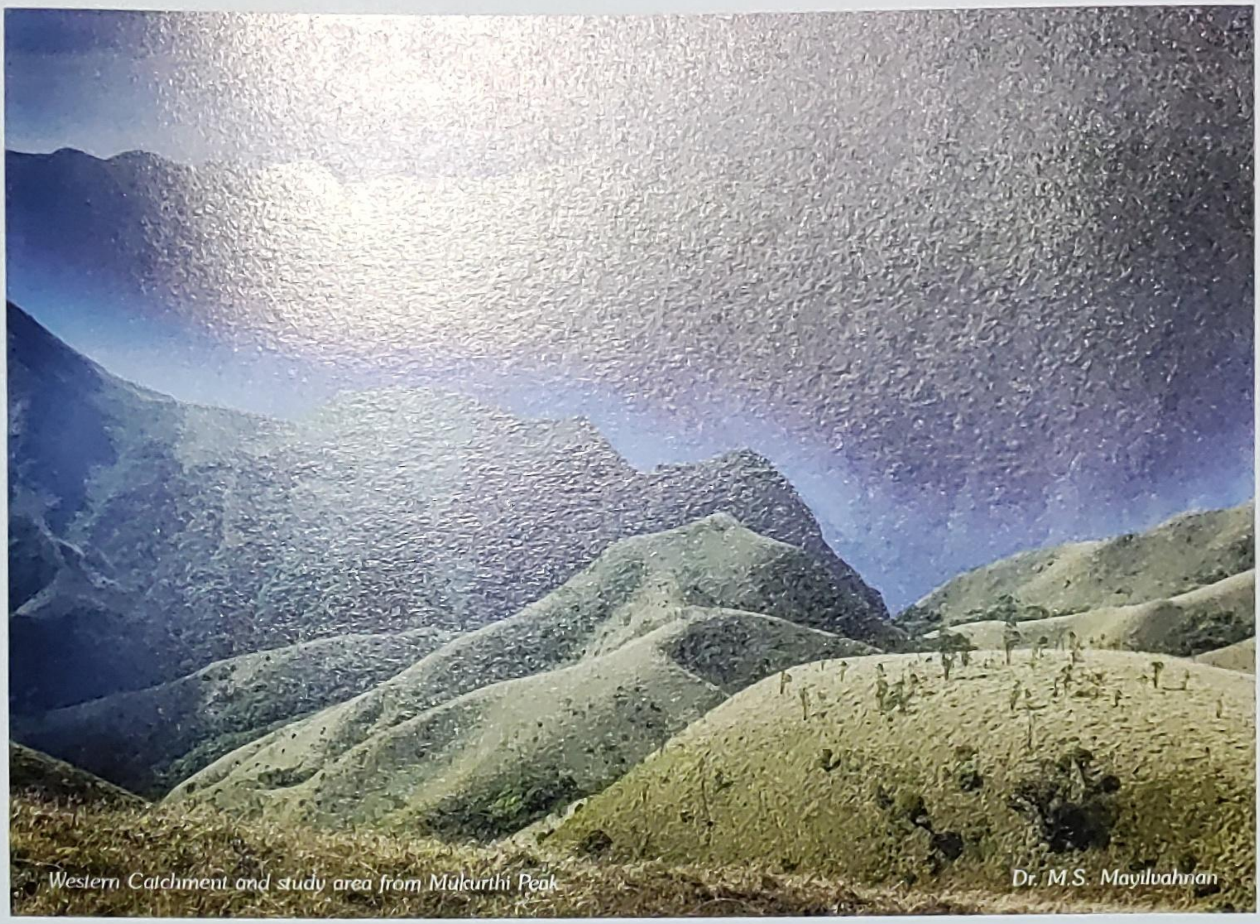
Leucas rosmarinifolia Endemic to the Nilgiris. Wight reports this species to grow abundantly at Kaitie, Fyson says it is to be found near Ootacamund and Kotagiri. Nowadays it can be observed commonly in the National Park.

Species Found Then but Not Now

Senecio neelgherryanus	Reported by Fyson and Gamble from the Kundahs.
Oldenlandia sisparensis	Reported by Gamble from above Sispara.
Anisochilus suffruticosa	Reported by Wight on rocky places near Sispara.
Pogostemon paludosus	Reported by Fyson and Gamble from Sispara at 6000-7000 ft.
Vernonia malabarica	Reported by Gamble from Sispara

Our two-year study confirmed the following:

Exotic plant species must be removed or the grasslands of Mukurthi will surely die.



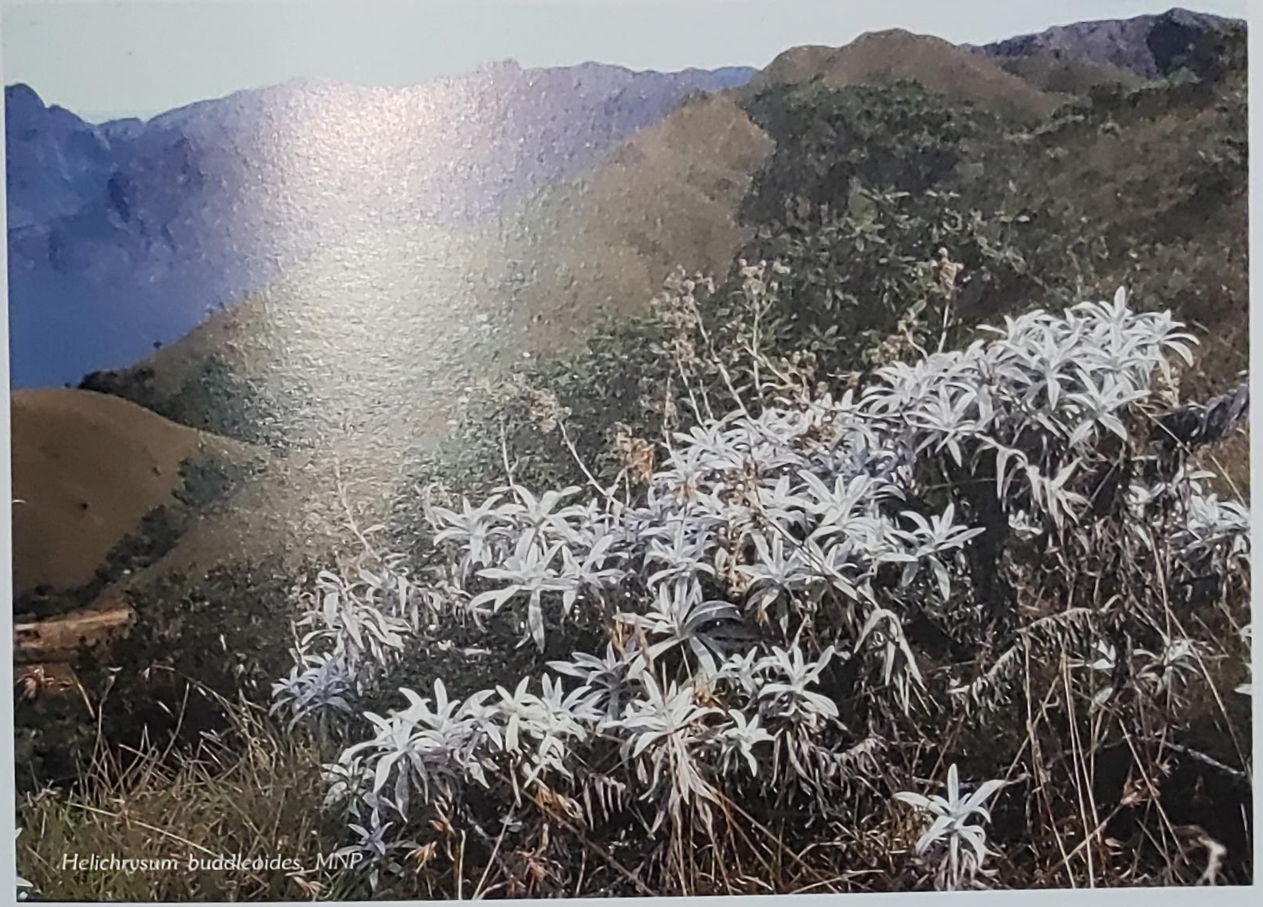
Western Catchment and study area from Mukurthi Peak

Dr. M.S. Mayilvahnan

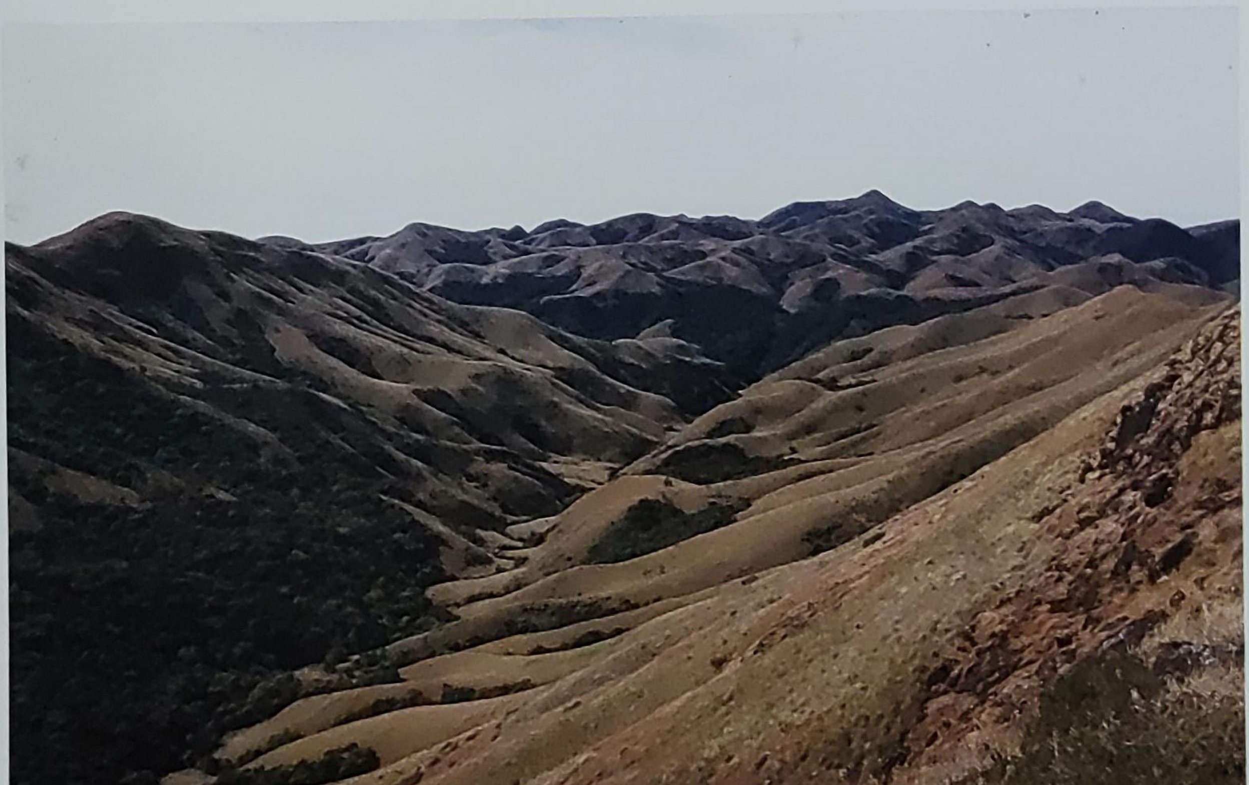
Escarpment, MNP

Angindamala from Bison Swamp, across Bhavanipuzha Valley

Kingerundi from Nadugani



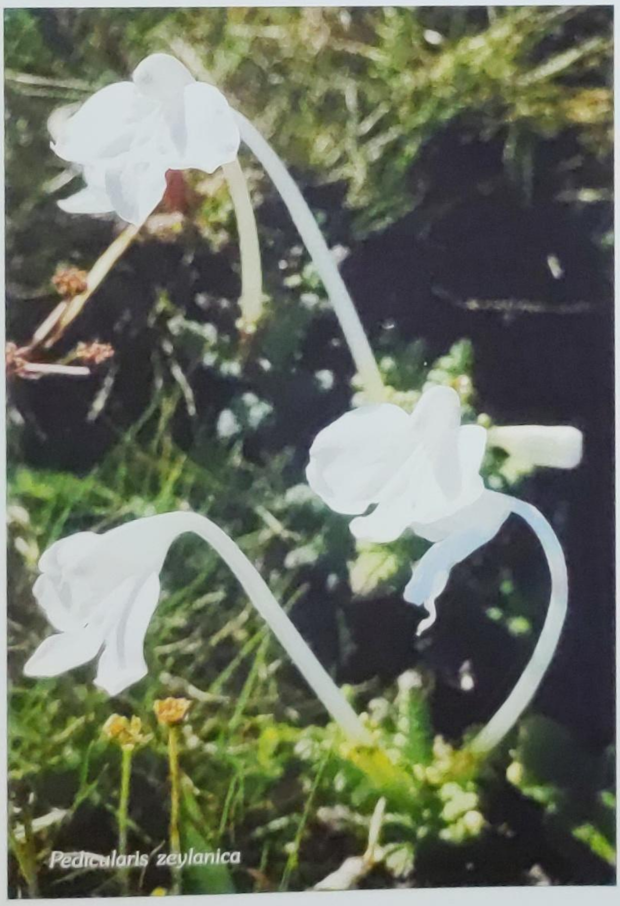
Helichrysum buddleoides, MNP



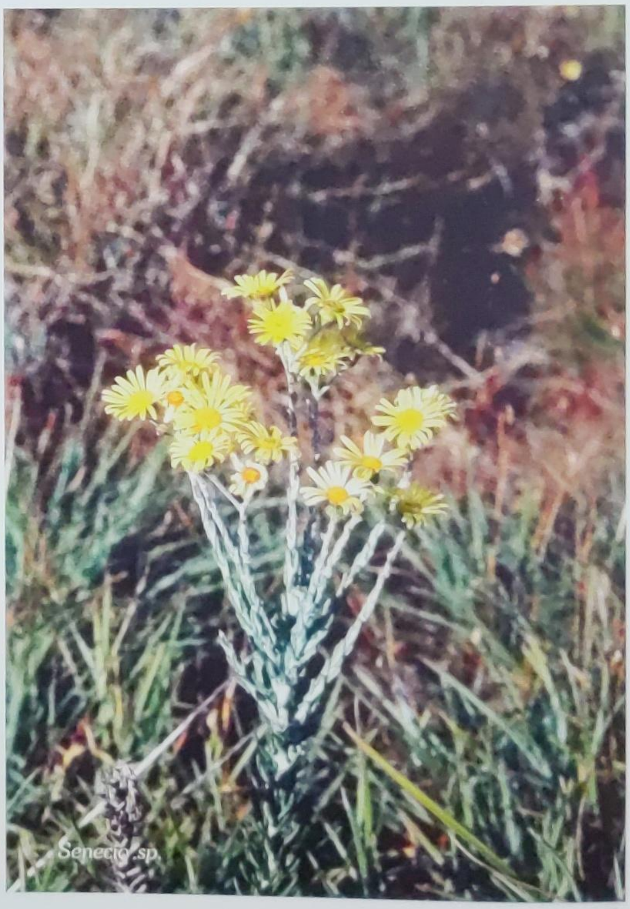
From Madippumalai : Shola only on eastern slope

Heterogeneity of habitat

© Pradip Krishen



Pedicularis zeylanica



Senecio sp.

Impatiens in moss on rock slope

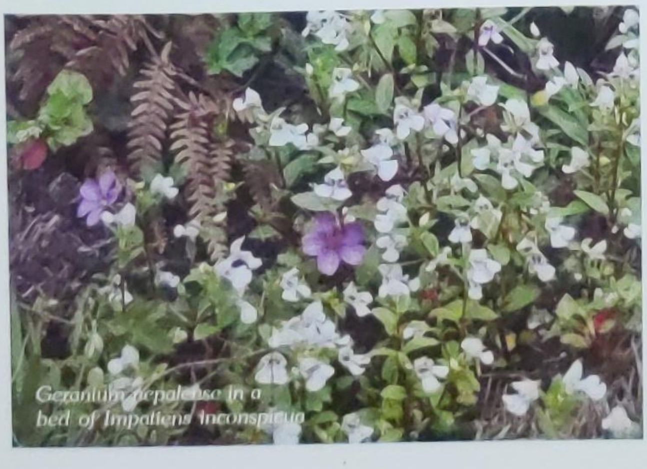
Grassland Community

Gentiana on bare ground

Hedyotis verticillaris

Alchemilla indica

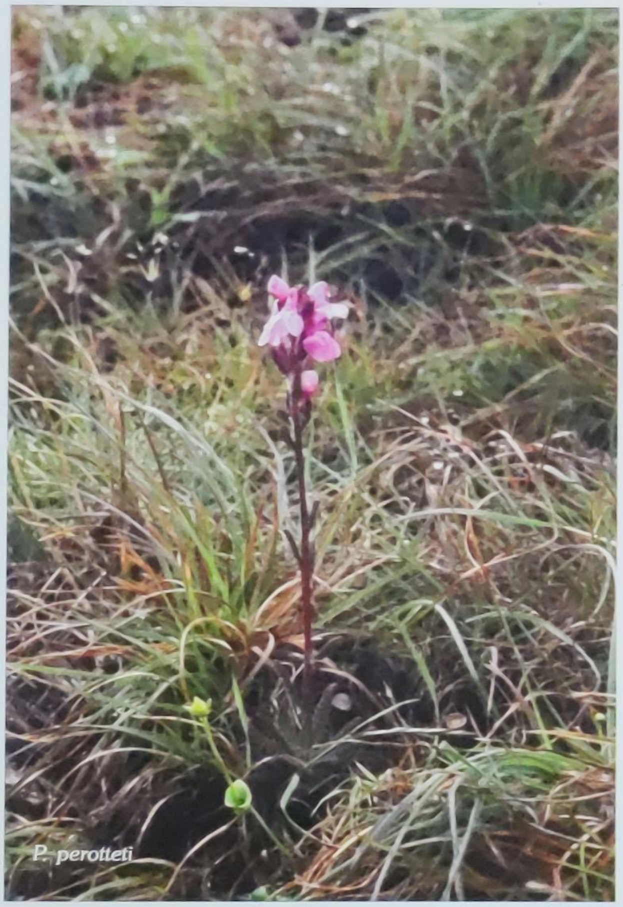
© Diba Sidiqal



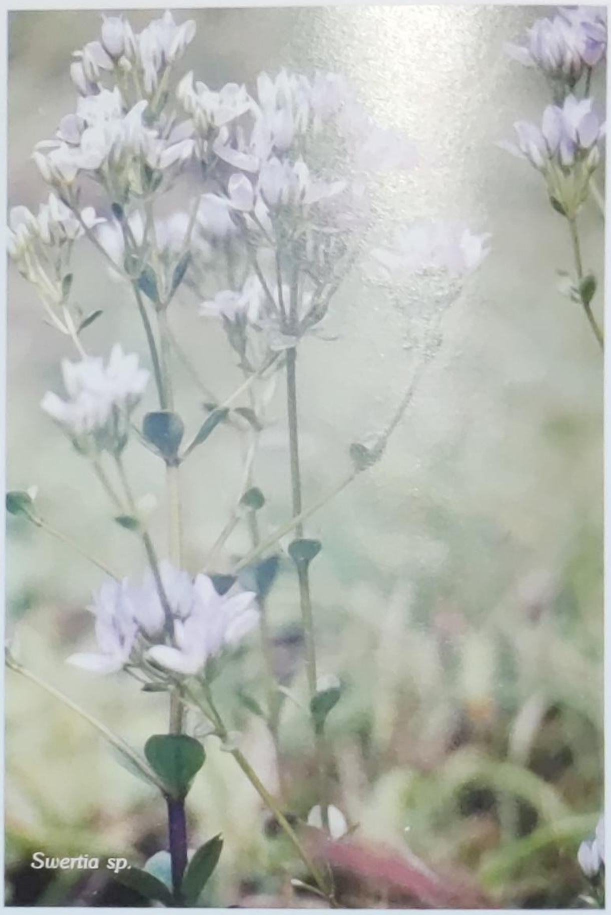
Geranium nepalense in a bed of Impatiens inconspicua

Sonerila sp.

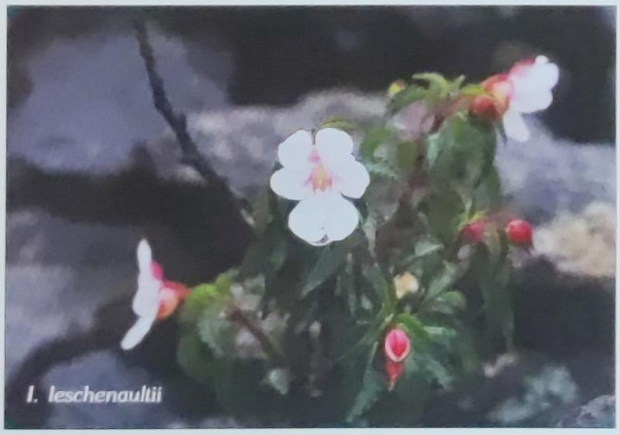
© Pradip Krishen



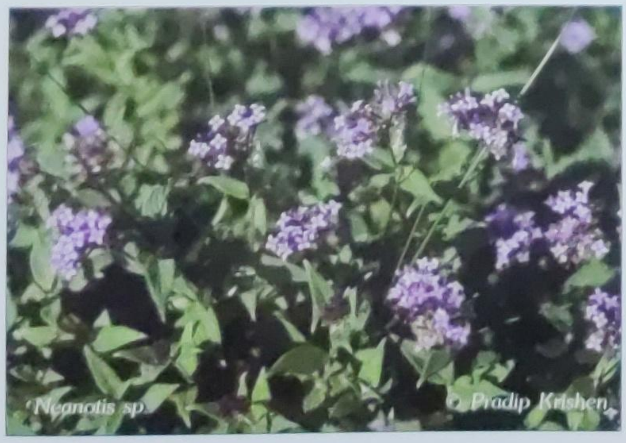
P. perotteti



Swertia sp.

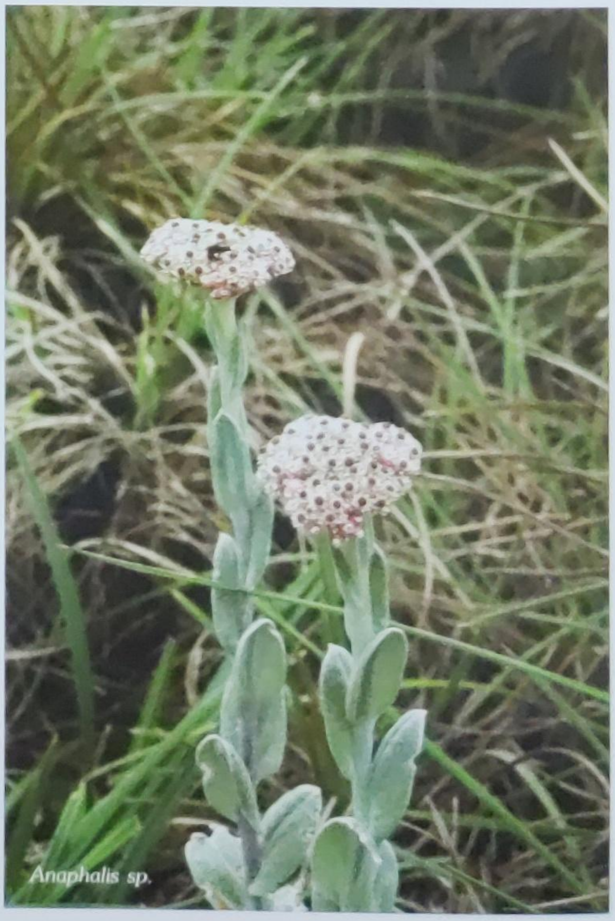


I. leschenaultii



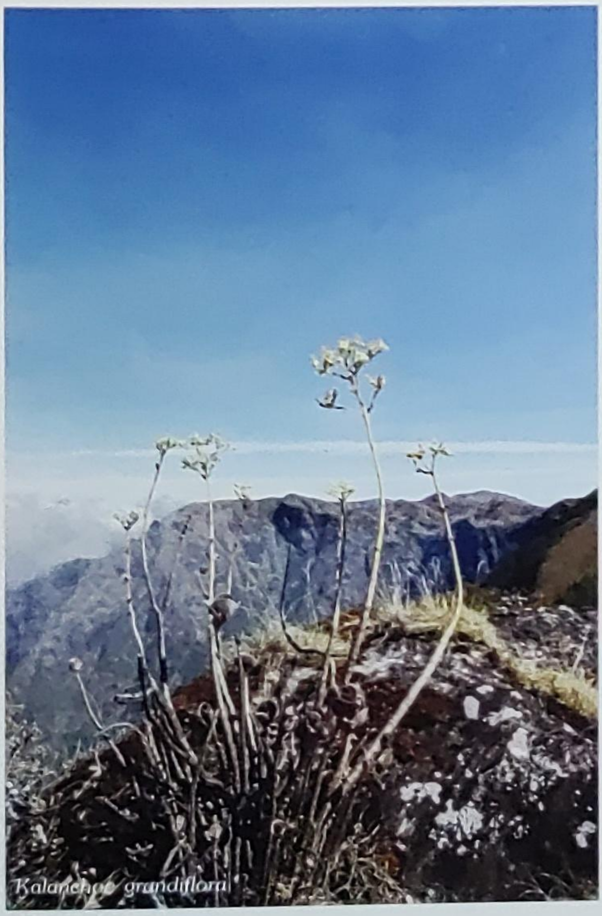
Neanotis sp.

© Pradip Krishen



Anaphalis sp.

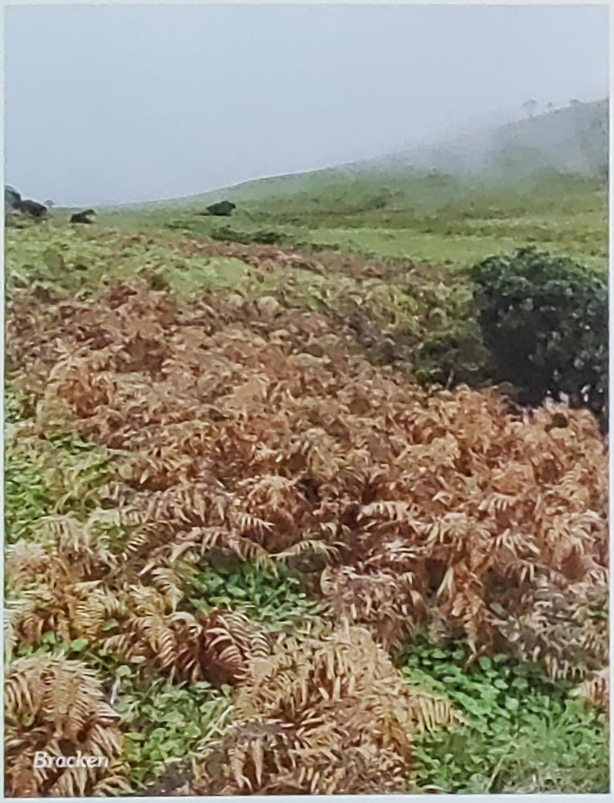
Rhododendron nilagiricum



Kalanchoe grandiflora

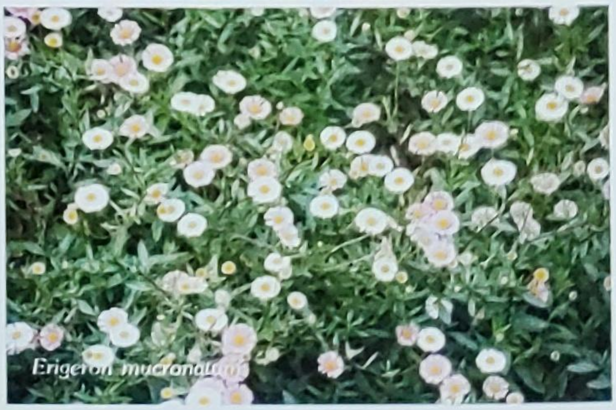
O. leschenaultii

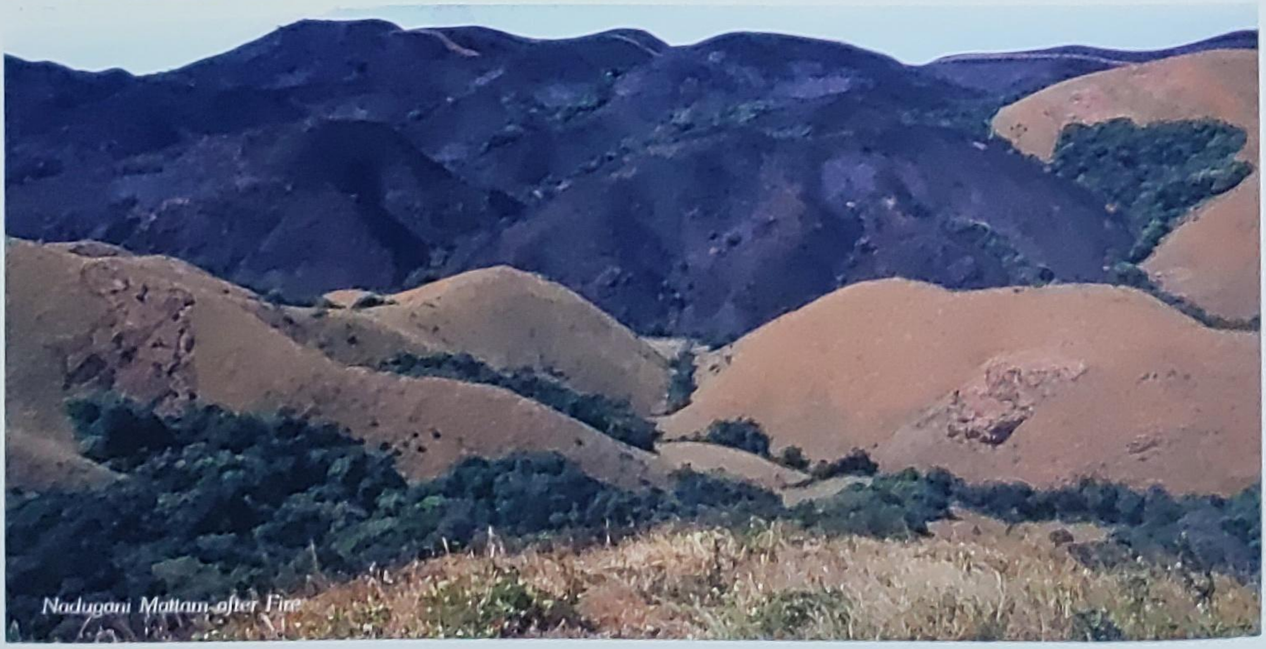
Impatiens sp.


Bracken

Wattle in flower

Gorse & Broom


Erigeron mucronatus


Nadugani Mattam after Fire

Questions, Discussion, Recommendations

Suprabha Seshan, Wolfgang Theuerkauf, Suma P., Laly Joseph

Six Intriguing Facts about Mukurthi National Park

- Of the 200 grassland species, 105 are endemic to south India, 77 are endemic to the Western Ghats and 22 are found in the Nilgiris alone.
- Mukurthi has the highest number of scapigerous *Impatiens* found in any one place, unit area, or landscape, in the world. This group is entirely endemic to the Western Ghats, half of which are found on this southwestern edge. We have been studying the *Impatiens*, particularly the scapigerous *Impatiens* of the south, for many years and can unequivocally assert the fact that they are extremely tender and delicate species, very vulnerable to climate change. Mukurthi itself may be a centre of speciation or natural hybridization, a process leading eventually to the formation of new species. For example, hybrids of *I. laticornis* and *I. lawsonii*; *I. clavicornu* and *I. pseudoacaulis* can be found.
- Some plants are found only within the Park (or close to it at Avalanche or Sispara) and nowhere else on the planet. Some occur in gregarious dense populations, (*Alchemilla, Hedyotis verticillaris, Impatiens clavicornu, etc.*) and others as isolated individuals (a strange shrubby *Impatiens* resembling *I. hensloviana*). How is it that there are so few of them?
- Relative to other montane areas of the south, Mukurthi is sparse in ground orchids. Could the digging for pits have had an effect on the populations of ground orchids, over and above climatic factors?
- Exotic plant species can be found in almost every corner of the Park. Many have traveled in on their own, without being planted. In this forbidding tropical terrain, with winter frost and gale force winds, the fastest-spreading plants are the exotics and one or two highly aggressive natives.
- Mukurthi is very small. Too small. And oddly long and narrow. Even with the contiguity to the Silent Valley National Park, the New Amarambalam Reserve Forest and the South Division Reserve Forests, the grassland area is absurdly small, over and above its utter lack of width. For habitats to retain their integrity, shape may matter. The press of wattle on the entire eastern edge will surely advance and cover the sliver of a strip that remains.

A National Park for Exotic Species?

It is unequivocally understood that the third greatest stress on the natural world, after habitat destruction and climate change, is the spread of invasive alien species. Some settle around urban areas or agricultural fields but others penetrate into the heart of natural environments with potentially devastating results.

All over the world exotic species are invading natural environments at a spectacular rate. Bio-invasion poses a threat more ominous, some people feel, than greenhouse gases, industrial pollution and ozone depletion. Alien invasive species operate on disturbed areas with a swiftness no native species can hope to match.

Mukurthi National Park occupies 77 square kilometres of the 2500 square kilometres of the Nilgiris. Every other area of the range is completely altered; only this western edge remains somewhat intact, somewhat whole. Of our study area (some 32 square kilometres in size), half is under exotics.

The march of wattle, gorse and broom into the park cannot be easily contained. Once established, all three species are difficult to eradicate. Wattle spreads through seed. It also coppices well. It forms dense stands, virtually impenetrable thickets into which other species cannot enter. Wattle seeds can remain sleepers for a hundred years and the battle may get more furious next century if we do not take steps now. At least half of the study area is covered in wattle, pine, gorse and broom. Every corner, even the furthest, most inhospitable reaches harbour some or the other species of exotic now. Daisies, thistles, bracken, *Calceolaria* can be seen in most valleys. Straggling brushwood of wattle are also commonly seen. No vista is spared. Common weedy natives of cosmopolitan distribution can also start to dominate in areas that are repeatedly disturbed. *Rubus*, we fear, is also a big problem. The pitting that had taken place entailed a significant area of soil being dug up, subject to mechanical damage of a kind it had previously never known, which makes it easier for weeds to take hold, local or exotic. (*Note*: A weed is a plant that occupies disturbed ground, a common hardy pioneering species, it can be exotic or native.)

Wattle plantations are actually wastelands: not only do they impoverish the ecosystem but they also diminish the water collecting potential. The critical difference in ecological value between natural grassland and wattle plantations lies in the diversity of grasslands which generates soil fertility and water. Since all niches are occupied in a climactic climax, a stable environment is maintained.

Points for Discussion and Further Study

Population Viability

Cyathea crinita, a rare tree fern, is endemic to the Western Ghats. It is hardly to be seen in the wild anymore, aside from a few pockets in the High Ranges and Palnis. Mature individuals are very uncommon. We have found sporelings in good numbers in only perhaps three places in the Western Ghats. Bangithappal is one of them. What is to be done for this exceedingly rare species, which we know had a better distribution previously and is not just naturally rare?

The southwestern edge of the Nilgiri horst is richest in diversity for an unusual group of plants, the scapigerous *Impatiens*, which are unique to south India. The distribution for each species is very narrow but was probably wider previously. They are all globally threatened species. This group, along with other unusual plants found in MNP, requires careful study of population viability. From our observations across the Ghats, this group is highly susceptible to changes in the environment, particularly those related to humidity, temperature and the presence of invasive species.

Alchemilla indica, a species with a previously wider distribution is now found *only* within Mukurthi National Park. Although gregarious and dense in its growth habits, and clearly in good health (the three main populations within the Park), it remains to be seen how viable it is.

Hedyotis verticillaris, another narrow endemic can be seen growing gregariously within the Park and also in fringe areas up to Avalanche. But this is the limit. This species is found nowhere else.

A Population Viability Analysis for these groups is highly recommended.

Another component that merits study is the fluctuation of natural plant populations in protected areas. A two-year survey period cannot tell us much about fluctuations in the wild. Studies in this direction should be included in the long term conservation and restoration programme for the National Park.

Fire and Diversity

We observe that fire induces diversity. But how much fire is good? And how frequently? Should fire be used deliberately in areas where woody species are spreading onto the grassland? Why are they spreading?

Ecosystem Health and Exotics

The presence of *Eupatorium glandulosum, Erigeron mucronatum, Calceolaria mexicana* and three species of exotic grass, over and above the scattered populations of straggly wattle in the interior parts of the study area, raises questions about the spread of exotics. In addition, the march of the Scotch broom and gorse on the eastern fronts is aggressive. There are also huge areas where wattle and pine have taken over and are well established and self-propagating, and some are notoriously difficult to eradicate. Can exotic species eradication be undertaken systematically and can this be monitored?

What should our measure of 'ecosystem health' be? With which other high-altitude grassland ecosystem could we draw comparison? Which of our other 'pristine' montane ecosystems have suffered a similar complex of disturbances?

For at least 200 years prior to the formation of the National Park, there has been sustained and significant interference. Our investigations have not allowed us to establish a historical picture of the place before human intervention. The descriptions of the colonial botanists lack information on distribution patterns, ecological details and status of species. Without a historical rule of thumb for comparison what is the model to be followed for restoration? In such cases we have to rely on experience and intuition by examining the landscape ecology and the present distribution of species. We can draw inferences from historical information. We have seen the depletion of wild plant populations in the Nilgiris in places where direct interference from humans is not evident. Can we not surmise that depletion of species is happening within the Park also? Knowing that we cannot gauge with 100% certainty the exact location of any species, we can nevertheless draft a picture of what a healthy landscape would look like and be sure that our restoration efforts would result in a landscape which is beneficial to soil fertility, watershed and native species diversity.

Does Mukurthi National Park Require Restoration?

Absolutely.

Surely the fact that nearly 50% the Park area is under exotics is reason enough! Especially when large numbers of species worldwide are crossing the thin line between the critically endangered and the living dead. Especially when over 50% of the grassland flora are endemics to the region.

With only 10% of the planet's land surface under legal protection as National Parks, Sanctuaries or Reserves there is a desperate need to bolster these areas with the restoration of altered and degraded landscapes. Habitat fragmentation (i.e. the reduction in areas under natural cover into small isolated islands or pockets) has a drastic impact on the survival of species, particularly those that are endemic to a region. However, even protected areas can suffer from degradation if they are too small or if the pressures in the surrounding areas are too destructive.

MNP is roughly 3% of the total Nilgiri land area. And since so much is under wattle, we can conclude that less than 2% of the Nilgiris is original grassland.

While we do not have complete knowledge about how an ecosystem functions, and no ecosystem can be completely restored to primary conditions by human intervention in a short span of time, it is perhaps possible to 'nudge' or 'enhance' rates of succession. Ecological restoration is essentially an integrated and multidisciplinary approach. It is a form of *assisted biotic synthesis* and requires a range of approaches, from species re-introductions (where near or total extinction in the wild may have occurred) and regeneration, to intervention and active management, as well as 'leaving alone'. This will aid both the survival of species and the improvement of the habitat. Re-introduction requires detailed knowledge of the presence of species in the area, both in the past and in the present. Re-introduction of keystone species may even help the ecosystem's own processes to set in faster and to create conditions for other species to enter and establish themselves.

Strategic Recommendations

- Phased removal of woody exotics. Begin where the wattle is at its weakest. Undertake mechanical removal, avoid chemicals as they may have hazardous consequences in these fragile mountain ecologies. Repeat treatment successively.
- Removal of herbaceous exotics: *Calceolaria*, *Erigeron* etc. Student and volunteer groups with the help of the Nilgiri Wildlife Association can be recruited for removing these species as they are easy to recognize and easy to pull out by hand.
- Expand the area of the Park by increasing the width first. The eastern areas are anyway under exotic plantations which can be removed.
- Establish a fire protocol with controlled burns, preferably just after the height of the dry season. Controlled firing before peaking of grass biomass will help prevent the destruction of shola edges. Tender species amidst the grass get weakened by overgrown grass and also may get destroyed by intensity of fire.
- Employ experienced nursery people to collect seeds of endangered species and to establish a nursery either within or outside the Park.
- Boost degraded areas with tougher native species to bring back the community composition and structure faster.
- Conduct trials in species rehabilitation, re introducing climax species into areas which are in reasonably good health but lacking these species for some reason or another.

◆

Appendices

Historical Details of the Park Area

Compilation : T. Sandilya

Note: 1835- completion of path from Avalanchi to Sispara, via Bangitappal.

From Working Plans of the Forest Department

Dyson's working plan (1928 to 1938) for the Eucalyptus plantations and Hick's working plan (1927-1936) for the Mudumalai range forests gave place to the working plan of C. R. Ranganathan which was the first comprehensive plan covering the entire forest areas of the Nilgiris division. It was introduced in the year 1938 and was in force till 1948 with certain changes towards the later years. This plan was not revised till 1953 and hence works were carried on generally on the lines prescribed therein from 1948 to 1954 when the revised Working Plan took place.

- M. Thyagarajan, Working Plan for the Nilgiris
Division (1964-1974).

From C.R. Ranganathan's Working Plan for the Nilgiris Division (1938 to 1948):

411. *Experiments in afforestation on the Kundahs:* "1,433 pits 6 feet apart were dug in1922 at Bangi Tappal and *Acacia dealbata* seedlings were planted which had been raised in a nursery at Avalanche. In addition to this the soil was broken up to a depth of 3 to 4 inches and some seeds were sown. The work was fairly successful."

413. 1923: "A nursery was formed near the first stream on the Bangi Tappal path after the Bangi Tappal–Bison Swamp bifurcations. Alnus seeds obtained from the Naduvattam Cinchona Plantations were sown in the nursery and shaded by means of a pandal."

422. "No further work was done in the locality till 1932 when under the instructions of the Chief Conservator reafforestation of important catchment areas in the Kundas was resumed on a very small scale. The species tried were *Hakea saligna*, *Calitris* and Cypress. The work was done much late in the season, as no preparations were made in advance. *Hakea* had done best of all, but it was decided not to continue with the species, since what was wanted was a species that could be expected to spread by itself. The areas treated in 1932 were two plots at Bangi Tappal (one of them was called the Bhavani plantation) and the margin of the Avalanche-Lakkidi bridle path."

424. " In 1934 casualties were replaced in the 1932 and 1933 areas by the same methods."

426. "No new regeneration plots were opened in the Kundahs in 1935. Casualties in all existing plots were replaced with *basketed* plants in all cases, Calitris and Cypress being used in the Lakkidi plots, Calitris alone on the Avalanche bridle path and in the Bangi Tappal plots..."

427. "The following statement shows the small degree of success achieved in the new regeneration operations. The enumeration was made in 1935."

	No. Failed Patches	Total Patches
Bangi Tappal (Bhavani plantation)	139	268
Bangi Tappal (Rest- house plantation)	7	48

430. "In 1936 replacement of casualties was made with mossed plants. No replacements were made in the Bangi Tappal and Mukurthi plantations."

703. "*Burning by the Nilgiri Game Association.*- As already stated, Shikaris are responsible for a certain number of fires annually. The motive is to promote the growth of fresh grass during the hot weather for the game to feed upon. The best method of putting an end to such unauthorized burning is to anticipate it by official burning and the Nilgiri Game Association has in recent years been burning grass over appreciable areas at its own expense. It is suggested that the Association should continue this good work on a definite plan, especially in the areas north of the watershed between Bangi Tappal and Mukurthi peak and in the country southwest of Bangi Tappal up to Sispara."

Ranganathan's working plan was revised in 1953 by T. Jayadev whose working plan was introduced in the year 1954. Like its predecessor, Jayadev's plan was a comprehensive one covering every aspect of management of the entire forest area. Apart from the various working circles, it provided for afforestation of the Wenlock Downs and the Kundahs which was the forerunner for raising of large scale plantations on the plateau under the successive five- year plans during the same period." - M.Thyagarajan, Working Plan for the Nilgiris Division (1964 to 1974)

From T. Jaydev's Working Plan for the Nilgiris Forest Division (1954 to 1964):

271. "Wattle plantations. - The creation of wattle plantations is one of the special works undertaken in the Nilgiris Division during the past decade. The work had not been covered by any working plan. It was started on an experimental scale and it gained impetus as the trade relations with South Africa became strained and the import of wattle bark dwindled. The wattle planting commenced in the year 1939 and small plantations were raised in scattered acres all over the plateau. The compact regeneration areas on a large scale lie at present near Mukurthi."

272. "In G.O. Ms. No 3097, Development, dated 14th December 1949, the Chief Conservator of forests was asked to investigate into the possibility of growing wattle on a large scale in selected areas in the Nilgiris and Palnis. Accordingly a scheme was drawn up in 1939 by Browne which provided for the starting of experimental plantations over small areas from 1939 to 1942; and in the event of the plantations proving successful it was proposed to undertake regular plantations on a large scale."

372. "The future extension of wattle plantations will be confined to compact and large blocks near Mukurthi and towards Avalanche."

373. "The total area of the working circle is 3,434.81 acres, the area already under wattle plantations at present (1953) being 1,834.81 acres. The balance of the area in this working circle will be brought under wattle during the period of this plan."

386. *"Choice of species.*-The black wattle (*Acacia mollissima)* will be the only species used for raising the future wattle plantations." From M. Thyagarajan's Working Plan for the Nilgiris Forest Division (1964 to 1974)

346. "Burning of grassland.- regular burning of grass is a characteristic feature of the grazing in the Nilgiri plateau... The grasslands in the downs and the Kundahs are burned annually in order to obtain a fresh sprout of tender grass. This is an ancient custom of these pastoral people on the hills and had been officially recognized by the Government. In recent years the burning

has been done under strict control so that the shola vegetation may not be endangered. Apart from the usual advantages claimed by the grazers for regular burning before the pre-monsoon showers, the Todas allege that the burning has the affect of destroying insects and fungi harmful to cattle and that it causes the general sterilization of the grasslands. If annual burning is not done they feel that over grown grass apart from being infested with pests injurious to cattle will be so over grown that the firing of it would cause a more intense fire damaging the rhizomes. It has been observed by the author of this working plan that areas which are not subject to periodic fires carry mostly tall and coarse grasses which are not palatable and not relished by cattle while those grasslands which are subject to annual fires carry shorter and palatable grasses of different species."

360. "Under Jaydev's working plan plantations of wattle were raised in the Kundahs and under the five year plan schemes large scale wattle plantations came in to being covering extensive areas of grassland. By the end of 1963 about 30,000 acres had been brought under wattle."

Upper Bhavani Series

These plantations are situated on the western and northwestern side of Upper Bhavani Dam and Billithada Halla River and it ends beyond Bangithappal in its southern portion. These plantations were located up to the Kerala boundary i.e. the State boundary between Madras and Kerala. These areas were all undulated grasslands with stunted Rhododendron trees here and there and apart from the above there are numerous patches of natural sholas in the depressions and in the valleys. These areas are very steep in some places and occur in all aspects.

These areas were selected and surveyed and demarcated leaving out the patches of sholas and aligned, pitted and planted with Acacia *mearnsii* at an espacement of 11x11 feet. The latest plantations which were planted with *Acacia mearnsii* in the same locality where the grass patches were vacant in between the older plantations, the espacement adopted was 8½x8 ½ feet. All the standard technique for planting was adopted by mixing 56. 70 grams of wattle fertilizer to each pit before planting to accelerate the growth of the seedlings. The plantations raised by the Kundah Soil Conservation Unit are also included in this compartment. There are wind belts along the ridges and spurs raised by the Kundah Soil Conservation Unit in these plantations to protect the plants from wind.

☆☆☆

Grassland Species Inventory

T. Sandilya

Our team identified 198 species of Angiosperms and Pteridophytes were in the study area. Most are widely distributed in the National Park but some are found in just one or two locations. Plant identification was done in the field with the help of the reference books by P.F Fyson and J.S Gamble and other botanical records. Nomenclature from Flora of the Palni Hills by Fr. Mathew, in consultation with Dr. Henry Noltie. Distribution information as per Gamble, Mathew, Hooker and Fyson. Grass species have been identified by Kiran Raj of the Calicut University. We also cross referenced several species with Bob Stewart and Tanya Balcar from Vattakanal Shola Tree Nursery.

Key to Terms

Abundant	occurring profusely
Common	occurring repeatedly
Occasional	occurring sporadically
Rare	occurring once or twice
Social setting	the plant in relation to others of the same species
Colony	many plants clumped together to form one mass, e.g. *Eriocaulon robustum*
Gregarious	many plants growing together, though not as crowded as in colonies, e.g. *Hedyotis verticillaris*
Scattered	when growing together but interspersed with other species, e.g. *Senecio lavandulifolius*
Single	when one plant is growing distantly from another, e.g. *Kalanchoe grandiflora*
Annual	any plant that completes its life cycle in the period of one year
Perennial	any plant whose life cycle lasts longer than one year
Dormant	perennials, dormant during a part of the year (usually the dry period) in the form of bulbs, tubers, rhizomes, etc.

Angiosperm List

Species	Preferred grass-land type	Distribution/ locality	Relative abundance	Social setting	Flowering	Annual/ Perennial	Distribution
Ranunculaceae							
Ranunculus subpinnatus	Marshy	Bangitappal	Rare	Scattered	Oct-Nov	Dormant	South and North India, Burma, China
Ranunculus reniformis	Marshy, dense patchy	Throughout the area	Occasional	Scattered	Oct-	Perennial	Endemic-South India
Cruciferaceae							
Cardamine hirsuta	Patchy	Bangitappal	Rare	Scattered	Oct- Feb	Annual	Cosmopolitan weed
Violaceae							
Viola serpens	Shola edge	Throughout the area	Occasional	Scattered	Nov-Apr	Perennial	South Asia mountains
Polygalaceae							
Polygala sibirica	Patchy	Throughout the area	Occasional	Scattered	Oct- Mar	Perennial	Himalayas, China, W. Ghats
Hypericinaceae							
Hypericum mysurense	Patchy, rocky,dense	Throughout the area	Occasional	Scattered	Oct-Mar	Perennial	Hills of S. India, Sri Lanka.
Hypericum hookerianum	Shola edge	Bangitappal, Sispara	Rare	Single	-Mar	Perennial	Peninsula
Hypericum wightianum	Marshy, stream-side	Throughout the area	Occasional	Scattered	Mar-	Annual	Peninsula
Theaceae							
Eurya nitida	Shruby, dense,patchy, rocky	Throughout the area	Occasional	Single	Nov-Dec	Perennial	Asia

Linaceae							
Linum mysorense	patchy	Madippumalai	Rare	Scattered	Nov-	Annual	Himalayas, Sri Lanka, W. Ghats
Geraniaceae							
Geranium nepalense	Dense	Bangitappal	Occasional	Single	Oct- Nov	Dormant	South Asian mountains
Oxalidaceae							
Oxalis corniculata	Patchy	Bangitappal	Rare	Scattered	Oct-	Annual	Cosmopolitan weed
Balsaminaceae							
Impatiens acaulis	Rocky	Throughout the area	Common	Gregarious	Aug -Oct	Dormant	Endemic-W. Ghats
Impatiens clavicornu	Patchy, dense, rocky	Throughout the area	Abundant	Scattered	Aug -Oct	Dormant	Endemic-Nilgiris
Impatiens diversifolia	Dense, patchy	Throughout the area	Common	Scattered	Aug -Nov	Annual	Endemic- Western Ghats
Impatiens laticornis	Shola edge	Throughout the area	Common	Gregarious	Aug -Oct	Dormant	Endemic- Nilgiris
Impatiens leschenaultii	Shola edge	Throughout the area	Occasional	Single	Sep-Apr	Perennial	Endemic-Western Ghats (Nilgiris Palnis, Anamalais)
Impatiens munronii	Shola edge	Bangitappal, Sispara	Rare	Scattered	Sep-Apr	Perennial	Endemic-Nilgiris
Impatiens inconspicua	Rocky, patchy	Throughout the area	Common	Gregarious	Sep- Nov	Annual	Endemic- Western Ghats
Impatiens rufescens	Marshy	Bangitappal	Occasional	Single	Aug -Oct	Annual	Endemic- Nilgiris
Papilionaceae							
Crotalaria calycina	Patchy	Solakal malai	Rare	Scattered	Oct-	Annual	Nilgiris and Palinins
Crotalaria formosa	Dense, patchy	Anginda malai, Nadugani	Rare	Single	Nov-Feb	Perennial	Endemic-Nilgiris
Crotalaria scabrella	Patchy, rocky	Throughout the area	Occasional	Single	Oct-Dec	Dormant	South India, Sri Lanka
Crotalaria sp.	Shola edge	Throughout the area	Occasional	Single	Sep-Dec	Perennial	
Cytisus scoparius	Patchy	Earth dam	Common	Gregarious	Oct- Mar	Perennial	Exotic
Smithia blanda	Patchy, dense, rocky	Throughout the area	Common	Scattered	Sep- Dec	Dormant	South India, (Father Matthew)
Ulex europaeus	Patchy	Earth dam	Occasional	scattered	Oct- Mar	Perennial	Exotic

Mimosaceae							
Acacia melanoxylon	Dense, patchy	Earth dam south to Bhavani bridge	Occasional	Scattered		Perennial	Exotic
Acacia mollisima	Dense, patchy	Earth dam south to Bhavani brdge	Common	Scattered		Perennial	Exotic
Rosaceae							
Alchemilla indica	Dominated by the same	Bangitappal, Labor shed	Abundant	Gregarious	Apr-	Perennial	Nilgiris, Palinis
Fragaria nilgerrensis	Patchy	Throughout the area	Occasional	Scattered	Feb-Apr	Perennial	India, China, Nepal
Potentilla leschenaultiana	Patchy, marshy	Throughout the area	Occasional	Scattered	Feb-Apr	Perennial	S. India, Himalayas, Nepal
Rubus ellipticus	Shola edge	Throughout the area	Common	Scattered	Dec-	Perennial	S. and N. India
Rubus fairholmianus	Shola edge, patchy	Throughout the area	Common	Gregarious	Aug-	Perennial	S. India, Sri Lanka
Rubus niveus	Shola edge	Throughout the area	Common	Scattered	Dec-	Perennial	India, Sri Lanka, Burma
Crassulaceae							
Kalanchoe grandiflora	Rocky	Earth dam	Rare	Single		Perennial	Endemic- Western Ghats (Nilgiris, Palnis)
Saxifragaceae							
Parnassia mysorensis	Rocky, patchy	Throughout the area	Occasional	Scattered	Aug- Oct	Dormant	Nilgiris, Palnis
Parnassia wightiana	Marshy	Bangitappal	Rare	Scattered	Aug-Oct	Dormant	China, S. and N. India
Droseraceae							
Drosera burmanni	Marshy	Throughout the the area	Occasional	Scattered	Dec-Mar	Dormant	India
Drosera peltata	Rocky, patchy, dense	Throughout the area	Common	Scattered	Oct-Dec	Dormant	Western Ghats
Haloragiaceae							
Serpicula brevipes	Marshy, patchy	Throughout the area	Occasional	Scattered	Sep-Dec	Annual	Nilgiris and Palnis

Myrtaceae							
Rhodomyrtus tomentosa	Rocky, dense, patchy	Throughout the area	Common	Scattered	Dec-Apr	Perennial	S. India, Sri Lanka, Indochina
Melastomataceae							
Osbeckia brachystemon	Patchy	Throughout the area	Common	Scattered	Sep-Nov	Dormant	S. India
Osbeckia leschenaultiana	Patchy, dense, shola edge	Throughout the area	Occasional	Scattered	Nov-Mar	Perennial	Endemic-Western Ghats (Nilgiris, Palnis)
Osbeckia sublaevis	Rocky	Nadugani, Sispara	Rare	Scattered	Oct-Nov	Perennial	Endemic- Nilgiris
Sonerila gamblei	Rocky	Throughout the area	Occasional	Scattered	Oct-Dec	Perennial	Endemic-Mukurti
Sonerila spec.	Streamside	Bangitappal	Occasional	Gregarious	Apr-	Perennial	Endemic- Mukurti
Sonerila rotundifolia	Rocky	Path to Nadugani	Occasional	Scattered	Aug-	Dormant	S. India
Umbelliferae							
Bupleurum distichophyllum	Dense, patchy	Throughout the area	Common	Scattered	Sep-Dec	Dormant	Endemic- Western Ghats (Nilgiris, Palnis)
Heracleum ceylanicum	Dense, patchy	Throughout the area	Occasional	Scattered	Nov-Dec	Dormant	S. India, Sri Lanka
Pimpinella candolleana	Dense, patchy	Throughout the area	Occasional	Scattered	Sep-Nov	Dormant	Endemic- South India
Pimpinella leschenaultii	Patchy	Madippumalai	Rare	Scattered	Jan-	Dormant	S. India, Sri Lanka
Rubiaceae							
Neanotis wightiana	Patchy, patchy, rocky	Throughout the area	Common	Gregarious	Sep-Jan	Perennial	S. India
Hedyotis articularis	Dense, shrubby, rocky	Throughout the area	Common	Scattered	Aug-Dec	Perennial	S. India
Hedyotis hirsutissima	Dense, patchy, rocky, shola edge	Throughout the area	Occasional	Single	Oct-Nov	Perennial	Endemic- Nilgiris
Hedyotis leschenaultiana	Dense, shrubby	Throughout the area	Common	Scattered	Aug-Apr	Perennial	Nilgiris and Palnis
Hedyotis verticillaris	Dominated by the same	Throughout the area	Common	Gregarious	Sep-Apr	Perennial	Endemic- Nilgiris

Valerianaceae							
Valeriana leschenaultii	Shola edge	Path to Nadugani	Occasional	Scattered	Feb-Apr	Dormant	Endemic – Nilgiris
Dipsacaceae							
Dipsacus leschenaultii	Patchy	Sispara	Rare	Scattered	Sep-Nov	Perennial	Endemic-Western Ghats (Nilgiris-Palnis)
Asteraceae							
Anaphalis elliptica	Patchy	Nadugani	Occasional	Scattered	Mar-	Annual	Endemic-Western Ghats (Nilgiris, Anamalais)
Anaphalis lawii	Patchy	Throughout the area	Occasional	Scattered	Sep-Nov	Annual	S. India
Anaphalis leptophylla	Dense, patchy	Nadugani, Sispara Solakalmalai,	Occasional	Single	Sep-Jan	Perennial	Endemic- Western Ghats (Nilgiris, Palnis)
Anaphalis macrescens	Stream side	Throughout the area	Occasional	Scattered	Sep- Jan	Perennial	Nilgiris
Anaphalis neelgerryana	Rocky, patchy	Throughout the area	Occasional	Scattered	Aug-Nov	Perennial	Endemic-Nilgiris
Anaphalis notoniana	Patchy, dense	Nadugani, Solakalmalai	Rare	Scattered	Jan-Mar	Perennial	Endemic- Nilgiris
Anaphalis sp.	Cliffside	Along plateau edge	Occasional	Scattered	Oct-Feb	Perennial	
Anaphalis wightiana	Patchy, dense	Throughout the area	Common	Scattered	Aug-Oct, Dec-Apr	Perennial	S. India
Blumea hieracifolia	Shola edge	Path to Nadugani	Occasional	Scattered	Apr-	Perennial	India, Burma, Indochina
Centratherum reticulatum	Marshy	South of Madippumalai	Rare	Single	Aug-Oct	Perennial	S. India, Madya Pradesh, Sri Lanka
Cirsium wallichii	Streamside, marsh	Throughout the area	Occasional	Scattered	Aug-Sep	Dormant	India
Conyza stricta	Patchy, dense	Throughout the area	Occasional	Single	Oct-Apr	Perennial	S. India
Launaea japonica	Shola edge	Throughout the area	Occasional	Scattered	Oct-Dec	Dormant	Southeast Asia
Dichrocephala chrysanthemifolia	Streamside	Bangitappal, Nadugani	Occasional	Scattered	Apr-	Annual	Africa, West to Southeast Asia
Emilia scabra	Rocky, patchy	Throughout the area	Common	Scattered	Sep-Jan	Dormant	Africa, Asia
Erigeron mucronatum	Patchy	Throughout the area	Common	Gregarious	Oct-Apr	Perennial	Exotic
Eupatorium glandulosum	Patchy, shola edge	Throughout the area	Occasional	Scattered	Dec-Mar	Annual	Exotic

Gnaphalium luteo-album	Streamside	Bangitappal	Occasional	Scattered	Apr-	Annual	India, Japan
Helichrysum bracteatum	Patchy	Nadugani	Rare	Scattered	Apr-	Perennial	Exotic
Helichrysum buddleioides	Shola edge	Throughout the area	Common	Scattered	Oct-Mar	Perennial	S. India
Helichrysum wightii	Dense, patchy	Throughout the area	Common	Scattered	Sep-Jan	Perennial	S. India
Hypochaeris glabra	Patchy	Throughout the area	Common	Scattered	Sep-Apr	Dormant	Exotic
Moonia heterophylla	Shola edge	Throughout the area	Occasional	Scattered	Nov-Mar	Perennial	S. India, Sri Lanka
Myriactis wightii	Shola edge	Throughout the area	Occasional	Scattered	Aug-Apr	Perennial	S. India, Sri Lanka
Picris heiracioides	Patchy	Bangitappal	Rare	Single	Apr-	Dormant	Asia, Australia, Europe
Senecio intermedius	Shola edge	Throughout the area	Occasional	Scattered	Nov-Feb	Perennial	S. India
Senecio lavandulifolius	Dense,patchy	Throughout the area	Common	Scattered	Nov-Feb	Perennial	Endemic- Western Ghats (Nilgiris, Palnis)
Senecio lawsonii	Dense, patchy	Throughout the area	Occasional	Single	Nov-Dec	Dormant	Endemic-Nilgiris
Senecio lessingianus	Rocky, cliff side	Madippumalai, along plateau edge	Rare	Gregarious	Nov-Feb	Dormant	Endemic- Nilgiris
Senecio polycephalus	Dense, patchy	Throughout the area	Occasional	Single	Sep-Nov	Dormant	Endemic-South India (Nilgiris, Shevaroys)
Senecio wightii	Marshy	Throughout the area	Occasional	Scattered	Sep-Nov	Dormant	S. India
Vernonia sp.	Patchy, shola edge	Sispara	Occasional	Scattered	Dec-Feb	Perennial	
Vernonia sp.	Shola edge	Bangitappal	Occasional	Scattered	Dec-	Perennial	

Campanulaceae							
Campanula alphonsii	Patchy, Rocky	Throughout the area	Not common	Gregarious	Nov-Feb	Perennial	Endemic- Wstern Ghats (Nilgiris, Palnis, Anamalais)
Campanula fulgens	Dense	Bangitappal	Rare	Single	Oct-Nov	Dormant	S. and N. India, Burma
Lobelia leschenaultiana	Shola edge, cliffside	Along plateau edge	Not common	Single	Dec-Mar	Perennial	Mountains of S. India
Wahlenbergia marginata	Patchy,dense	Madippumalai	Rare	Single	Oct-	Dormant	India, China, Japan, Australia
Ericaceae							
Gaultheria fragrantissima	Dense, patchy	Throughout the area	Common	Scattered	Nov-Apr	Perennial	India, Burma, Nepal
Rhododendron nilagiricum	Dense, patchy	Throughout the area	Common	Scattered	Nov-Mar	Perennial	Western Ghata
Primulaceae							
Lysimachia procumbens	Patchy	Nadugani	Occasional	Scattered	Apr	Dormant	India, Sri Lanka
Oleaceae							
Jasminum bignoniaceum	Patchy, shola edge	Throughout the area	Occasional	Single	Feb-Apr	Perennial	Endemic- Southern Western Ghats
Asclepidaceae							
Ceropegia pusilla	Patchy	Throughout the area	Occasional	Scattered	Apr-	Dormant	Endemic- Nilgiris, Anamalais
Gentianaceae							
Gentiana pedicellata	Patchy, marshy	Throughout the area	Common	Scattered	Sep-Nov, Jan-Apr	Annual	Western Ghata
Swertia corymbosa	Patchy	Throughout the area	Common	Scattered	Aug-Dec	Annual	Western Ghata
Boraginaceae							
Cynoglossum furcatum	Patchy, dense	Path to Nadugani	Rare	Single	Sep-Jan	Dormant	Western Ghats

Scrophulariaceae							
Calceolaria grandiflora	Patchy	Bangitappal	Common	Scattered	Oct-Jan	Annual	Exotic
Pedicularis perrottetii	Rocky	Madippumalai, Nadugani	Rare	Scattered	Sep-Oct	Dormant	Endemic- Western Ghats (Nilgiris, Anamalais)
Pedicularis zeylanica	Patchy	Throughout the area	Occasional	Scattered	Sep-Nov	Dormant	India, Sri Lanka
Sopubia trifida	Patchy	Throughout the area	Occasional	Scattered	Oct-Jan	Dormant	S. India, Sri Lanka, China, Phillipines
Striga lutea	Patchy	South of Madippumalai	Rare	Scattered	Oct	Annual	India, Southeast Asia, Africa, Madagascar
Lentribulariaceae							
Utricularia graminifolia	Marshy, streamside	Throughout the area	Occasional	Scattered	Nov-Apr	Annual	Western Ghats
Lentibularia squamosa	Stream side	Nadugani	Occasional	Scattered	Feb-Apr	Annual	Western Ghats
Acanthaceae							
Andrographis lobeliodes	Dense, patchy	Throughout the area	Common	Scattered	Sep-Jan	Dormant	Endemic- Nilgiris
Justicia latispica	Shola edge	Throughout the area	Occasional	Scattered	Nov-Mar	Perennial	Endemic- Western Ghats (Nilgiris, Palnis, Anamalais)
Justicia simplex	Dense, patchy	Throughout the area	Common	Scattered	Sep-Jan	Perennial	India, Malaysia
Strobilanthes kuntianus	Patchy,dense, Shrubby	Throughout the area	Common	Scattered	Sep-Jan	Perennial	Endemic- South India
Strobilanthes wightianus	Shola edge, shrubby	Throughout the area	Common	Scattered	Aug-Jan	Perennial	Endemic- Nilgiris
Lamiaceae							
Prunella vulgaris	Patchy, streamside	Throughout the are	Occasional	Scattered	Feb-Apr	Perennial	Asia, Europe, Africa, Australia
Chenopodium umbrosum	Dense, patchy	Throughout the area	Occasional	Single	Oct-Apr	Dormant	S. India
Leucas lancifolia	Shola edge	Throughout the area	Occasional	Scattered	Sep-Mar	Perennial	Endemic-Western Ghats (Nilgiris, Palnis)
Leucas rosmarinifolia	Rocky	Throughout the area	Occasional	Scattered	Aug-Nov	Perennial	Endemic- Nilgiris
Leucas suffruticosa	Patchy, dense	Throughout the area	Common	Scattered	Aug-Apr	Dormant	Endemic- Western Ghats (Nilgiris, Anamalais)
Micromeria biflora	Dense, patchy, rocky	Throughout the area	Common	Scattered	Oct-Mar	Perennial	Asia, Africa
Plectranthus barbatus	Rocky	Near Solakalmalai	Rare	Single	Oct-Nov	Perennial	S. India
Isodon nilgherricus	Rocky	Madippumalai	Occasional	Scattered	Oct-Dec	Dormant	Endemic- Western Ghats (Nilgiris, Palinis)

Isodon nilgherricus	Rocky	Madippumalai	Occasional	Scattered	Oct-Dec	Dormant	Endemic- Western Ghats (Nilgiris, Palinis)
Pogostemon atropurpureus	Shola edge	Nadugani	Rare	Single	Feb-	Perennial	Endemic- Nilgiris
Pogostemon mollis	Patchy	Path to Nadugani	Rare	Scattered	Feb-	Perennial	Endemic- Western Ghats
Pogostemon speciosus	Shola edge	Path to Nadugani	Rare	Scattered	Oct-Feb	Perennial	Endemic- Western Ghats (Nilgiris, Anamalais)
Teucrium wightii	Patchy	Throughout the area	Occasional	Scattered	Nov-Feb	Perennial	Endemic- Nilgiris
Plantaginaceae							
Plantago erosa	Stream side	Throughout the area	Occasional	Scattered	Jan-Apr	Dormant	India, Sri Lanka, China, Burma
Polygonaceae							
Polygonum sphaerocephalum	Shola edge	Throughout the area	Occasional	Scattered	Dec-Apr	Perennial	India, Nepal
Santalaceae							
Thesium wightianum	Rocky, patchy	Throughout the area	Not common	Scattered	Nov-Apr	Perennial	Endemic- Southern Western Ghats
Euphorbiaceae							
Phyllanthus gardnerianus	Rocky, patchy	Throughout the area	Occasional	Scattered	Jan-Apr	Perennial	S. India, Sri Lanka
Orchidaceae							
Aerides crispa	On rocks	Throughout the area	Occasional	Single	Feb-Apr	Perennial	Endemic- Western Ghats
Coelogyne glandulosa	Cliffside, shola edge	Along edge of plateau	Not common	Gregarious	Apr-	Perennial	Western Ghats
Coelogyne nervosa	Rocky, patchy	Throughout the area	Rare	Scattered	Feb-Apr	Perennial	Western Ghats
Eria reticosa	Shola edge	Throughout the area	Common	Colony	Jul-Aug	Perennial	
Eria tiagii	Shola edge	Throughout the area	Not common	Colony	Jul-Aug	Perennial	Endemic- Western Ghats
Habenaria barnesii	Patchy	Nadugani	Rare	Scattered	Sep-Nov	Dormant	Western Ghats
Habenaria cephalotes	Patchy, rocky	Throughout the area	Common	Scattered	Sep-Nov	Dormant	Endemic- Western Ghats
Habenaria digitata	Shola edge	Throughout the area	Common	Scattered		Dormant	S. India
Habenaria heyneana	Patchy Rocky	Throughout the area	Occasional	Scattered	Sep-Nov	Dormant	S. India
Peristylus spiralis	Patchy, dense	Throughout the area	Not common	Scattered		Dormant	S. India, Sri Lanka

Satyrium nepalense	Patchy, rocky, dense	Throughout the area	Common	Scattered	Sep-Nov	Dormant	S. India, Sri Lanka, Nepal, Burma
Spiranthes sinensis	Patchy, marshy	Bangitappal, Nadugani	Not common	Scattered	Apr-	Dormant	India, China
Amaryllidaceae							
Curculigo orchioides	Patchy	Throughout the area	Common	Scattered	Jan-Mar	Dormant	India, Java, Phillipines
Liliaceae							
Asparagus fysonii	Patchy	Nadugani	Rare	Scattered	Feb-Mar	Perennial	Endemic- Western Ghats (Nilgiris, Palnis, Anamalais)
Chlorophytum malabaricum	Patchy	Throughout the area	Occasional	Single	Sep-Oct	Dormant	Endemic- Western Ghats
Juncaceae							
Juncus inflexus	Marshy	Throughout the area	Common	Gregarious	Oct-Mar	Perennial	Asia, Africa, Europe
Juncus leschenaultii	Stream side	Throughout the area	Not common	Scattered	Oct-Mar	Annual	India, China, Japan, Nepal
Araceae							
Arisaema leschenaultii	Shola edge, rocky	Throughout the area	Occasional	Single	Apr-	Dormant	S. India
Eriocaulaceae							
Eriocaulon nilagirense	Marshy	Throughout the area	Not common	Scattered	Sep-Jan	Annual	Endemic- Western Ghats (Nilgiris, Palnis)
Eriocaulon collinum	Marshy, Patchy	Throughout the area	Common	Colony	Aug-Sep	Annual	S. India, Sri Lanka
Eriocaulon gamblei	Marshy	Throughout the area	Not common	Scattered	Oct-Mar	Annual	Nilgiris
Eriocaulon robustum	Stream side	Throughout the area	Common	Colony	Sep-Apr	Perennial	Endemic- Nilgiris

Cyperaceae							
Carex filicina	Marshy, patchy	Throughout the area	Common	Scattered	Oct-Dec	Annual	Western Ghats
Carex nubigena	Marshy, stream side	Bangitappal	Occasional	Single	Oct-Dec	Annual	India, Sri Lanka, China, Japan
Scirpus subcapitatus	Stream side	Throughout the area	Common	Scattered	Nov-Apr	Annual	India, Sri Lanka, Malaysia, China
Gramineae (Poaceae)							
Agrostis pilosula	Shola edge, Patchy	Throughout the area	Not common	Scattered	Aug- Dec	Annual/ Perennial	Endemic- Western Ghats
Agrostis setacea	Patchy	Bangitappal	Not common	Scattered	Oct-Dec		
Agrostis stolonifera	Rocky	Throughout the area	Not common	Scattered	Sep-Nov	Perennial	Asia, Europe
Dicanthium polyptychus	Dense, patchy	Throughout the area	Abundant	Gregarious	Feb-Mar	Perennial	The most common species in the area, dominating most of the 'dense'grassland Exotic
Andropogon lividus	Patchy	Throughout the area	Common	Scattered	Sep- Dec		S. India, Sri Lanka
Andropogon polyptychus	Patchy	Bangitappal			Sep-Jan	Perennial	Western Ghats
Anthoxanthum odoratum	Patchy	Bangitappal	Rare	Scattered	Sep-Dec	Annual	Asia, Europe
Arundinella purpurea	Patchy	Throughout the area	Not common	Scattered	Oct-Nov	Perennial	S. India
Brachypodium sylvaticum	Patchy	Bangitappal	Not common	Gregarious	Sep-	Perennial	Europe, Asia, Africa
Chrysopogon zeylanicus	Dense, damp places, streemside	Throughout the area	Common	Gregarious	Aug-Jan	Perennial	S. India, Sri Lanka
Chrysopogon asper	Patchy, rocky, dense	Throughout the area	Common	Scattered	Sep-Dec	Perennial	S. India
Dichanthium oliganthum	Rocky, patchy	Throughout the area	Not common	Scattered	Sep-Nov	Annual	S. India
Eragrostis sp.	Patchy	Labor shed	Rare	Single	Dec-		
Eulalia phaeotrix	Patchy, dense	Throughout the area	Common	Scattered	Sep-Dec	Perennial	S. India, Sri Lanka, Southeast Asia
Garnotia puchiparensis	Rocky	Throughout the area	Occasional	Scattered	Sep-Nov	Annual	?
Helictotrichon virescens	Patchy, Dense	Throughout the area	Common	Scattered	Sep-Dec	Perennial	India, Burma, Sri Lanka
Isachne kunthiana	Shola edge	Throughout the area	Common	Gregarious	Oct- Dec	Perennial	India, Sri Lanka, Southeast Asia

Ischaemum commutatum	Shola edge	Throughout the area	Not common	Gregarious	Sep-	Perennial	S. India, Sri Lanka
Ischaemum indicum	Patchy, dense	Throughout the area	Common	Scattered	Aug- Jan	Perennial	S. India, Southeast Asia
Ischaemum nilagiricum	Patchy, dense	Throughout the area	Not common	Scattered	Dec- Feb	Perennial	Endemic- Western Ghats (Nilgiris, Palnis)
Jansenella griffithiana	Rocky	Throughout the area	Occasional	Scattered	Oct-Nov	Annual	India, Sri Lanks
Poa gamblei	Patchy	Bangitappal	Not common	Scattered	Oct- Dec	Annual	Endemic- Nilgiris
Themeda tremula	Patchy, dense, shoal edge	Throughout the area	Common	Scattered/ Gregarious	Sep- Dec	Annual/ Perennial	S. India, Sri Lanka
Tripogon bromoides	Patchy, rocky	Throughout the area	Not common	Scattered	Sep-Nov	Perennial	S. India, Sri Lanka
Tripogon ravianus							Endemic- Nilgiris
Tripogon jacquemontii	Patchy, dense	Throughout the area	Common	Gregarious	Feb-		?

Pteridophyte List

Species	Preferred grassland type	Distribution/ locality	Relative abundance	Social setting	Annual/ perennial	Distribution
Lycopodiaceae						
Lycopodium wightianum	Patchy, rocky	Path to Nadugani Bangitappal	Occasional	Gregarious	Perennial	S. India
Lycopodiella cernua	Patchy, road cutting	Path to Nadugani	Rare	Gregarious	Perennial	S. India
Huperzia sp.	Streamside	Bangitappal	Rare	Single	Perennial	
Huperzia sp.	Rocky	Throughout the area	Occasional	Single	Perennial	
Gleicheniaceae						
Dicranopteris liniaris	Shola edge	Path Nadugani	Rare	Gregarious	Perennial	S. India
Osmundaceae						
Osmunda hugeliana	Streamside	Throughout the area	Common	Scattered	Perennial	India
Sinopteridaceae						
Cheilanthes bellangeri						
Lindseaceae						
Lindsea odorata	Damp open places	Throughout the area	Occasional	Gregarious	Perennial	Endemic- Southern Western Ghats
Dryopteridaceae						
Polystichum squarrosum	Shola edge, patchy	Throughout the area	Common	Scattered	Perennial	Endemic- Southern Western Ghats
Dryopteris sp.						
Thelypteridaceae						
Stegnogramma pozoi	Streamside	Bangitappal	Occasional	Scattered	Perennial	Asia
Polypodiaceae						
Crypsinus montanus	Rocky	Throughout the area	Occasional	Single	Dormant	South India, Sri Lanka
Dennstaedtiaceae						
Pteridium aquilinum	Patchy	Throughout the area	Common	Gregarious	Perennial	Cosmopolitan
Cyatheaceae						
Cyathea crinita	Road cutting	Bangitappal	Occasional	Scattered	Perennial	Endemic- southern Western Ghats
Athyriaceae						
Athyrium sp.	Under rocks	Path to Nadugani	Occasional	Gregarious	Dormant	

References

Abraham, A & Vatsala, P; 1981; Introduction to Orchids; Tropical Botanic Garden and Research Institute, Trivandrum

B. S. I; 1996; Flora of India; Calcutta

Beddome, R. H; 1863-1864; The Ferns of Southern India and Ceylon; Madras

Beddome, R. H; 1883; A Handbook to the Ferns of British India, Ceylon and Malayan Peninsula; Calcutta

Beddome, R. H; 1874; Icones Plantarum Indiae Orientalis; Madras

Bor, N. L; 1960; The Grasses of Burma, Ceylon, India and Pakistan; Pergamon Press, Oxford

Cooke, T; 1901 – 1903; Flora of the Presidency of Bombay; Botanical Survey of India, Calcutta

"Forestry in the Colonies and in India", Indian Forester Vol. 16, Aguest Issue

"Forest Conservancy in India", Indian Forester Vol. 19, July Issue

Fyson, P. F; 1920; Flora of the Nilgiri and Pulney Hill-Tops

Fyson, P. F; 1932; The Flora of the South Indian Hill-Stations

Gamble, J. S; 1921; Flora of the Presidency of Madras; London

Hooker, J. D; 1875; The Flora of British India; London

Joseph, J; 1987; Orchids of Nilgiris; Botanical Survey of India

Manickam, V. S & Irudayaraj, V; 1991; Pteridophyte Flora of the Western Ghats – South India; New Delhi

Manilal, K. S; 1988; Flora of the Silent Valley; Calicut

Mathew, K. M; 1999; The Flora of the Palni Hills, S. India; The Rapinat Herbarium

Santapau, H & Kapadia, Z; 1966; The Orchids of Bombay; Calcutta

Sivarajan, V. V & Phillip Mathew; 1997; Flora of Nilambur; Dehra Dun

Sreekumar, P. V & Nair, V. J; 1991; Flora of Kerala – Grasses; Botanical Survey of India

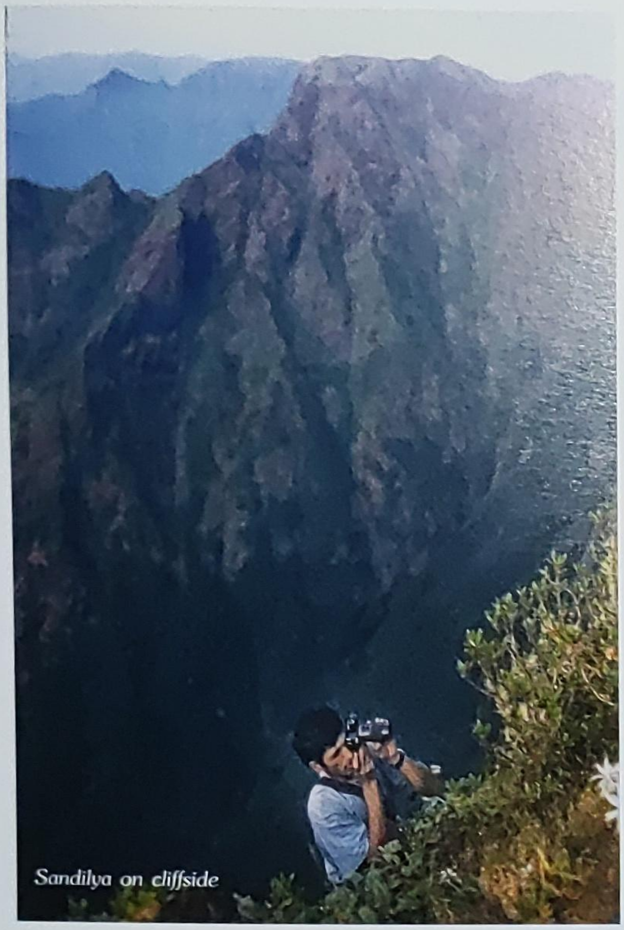
Sutton, Deborah, "What was a Spendid Wood", Shola, Forest Plantations and Colonial Conservancy in the Nilgiris 1937-1980, University of Lancaster

Wight, R & Walker-Arnott; 1834; Prodromus Florae Peninsulae Indiae Orientalis; London

Wight, R; 1843-1853; Icones Plantarum Indiae Orientalis; Madras

Working Plans for the Nilgiris, Ranganathan C. R (1938-1948), T. Jayadev (1954- 1964) and Tygarajan (1964-1974)

◆



Sandilya on cliffside

Kumar [illegible]

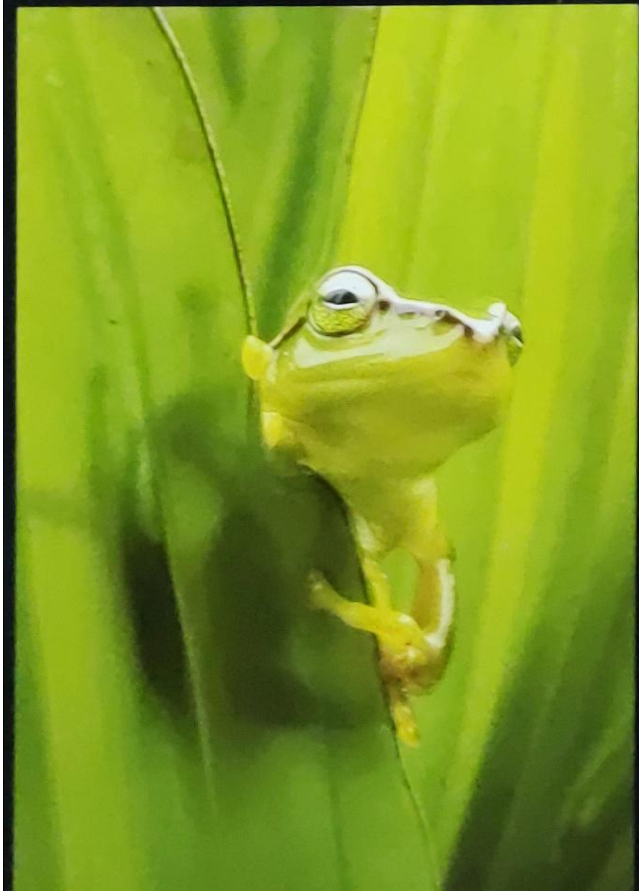
Eco-restoration Alliance meet[illegible]

Diba Siddiqi

Suprabha, Kullan, Kumar & Raja © Diba Siddiqi

Sandilya and Suma

Wolfgang and Suprabha © Christoph Tobler



Editors: Stefi Barna, Pradip Krishen
Design: Stefi Barna, Suprabha Seshan

Production : Gurukula Botanical Sanctuary
Foundation for Ecological Security

Printed at W.Q. Judge Press, B'lore
For Private Circulation only

the small

Plant Guide to Rao Jodha

DESERT ROCK PARK

pradip krishen

mehrangarh museum trust

the small

Plant Guide to Rao Jodha

DESERT ROCK PARK

pradip krishen

mehrangarh museum trust

Text & Photography
PRADIP KRISHEN

Layout & Design
KADAMBARI MISRA

Mehrangarh Museum Trust, Jodhpur
First published in 2011 by MMT Jodhpur
Copyright © 2011 MMT Jodhpur
Text & Photographs copyright © 2011 Pradip Krishen
All rights reserved.
No part of this publication may be reproduced, stored or transmitted
in any form without the prior written permission of the copyright owners.
ISBN 978-81-910471-3-4

Printed and bound in New Delhi by
Aegean Offset Printers

ACKNOWLEDGEMENTS

This publication would not have been possible without Bapji's unwavering vision and the support of the Trustees of the Mehrangarh Museum Trust and Karni Singh, Director of Mehrangarh Museum. Catherine Dohrn, Trustee of Parrotia Foundation (Switzerland) generously supported the 'last mile' of the opening of the Park, including this publication. Rao Raja Mahendra Singh, former CEO, MMT, played a seminal role in starting the work of the Park and shaping its direction. Several others have been pillars of support: Dr. Mahendra Singh Naggar, Director General, MMT; Shailesh Mathur, Engineer, MMT; and the wonderful team of people who work inside Rao Jodha Park, especially Devendra Yadav and Vinod Puri. We owe a real debt to the pioneering taxonomist of Marwar's desert flora, Prof. M.M.Bhandari, who is no longer with us. This first publication of the Park is dedicated to his memory.

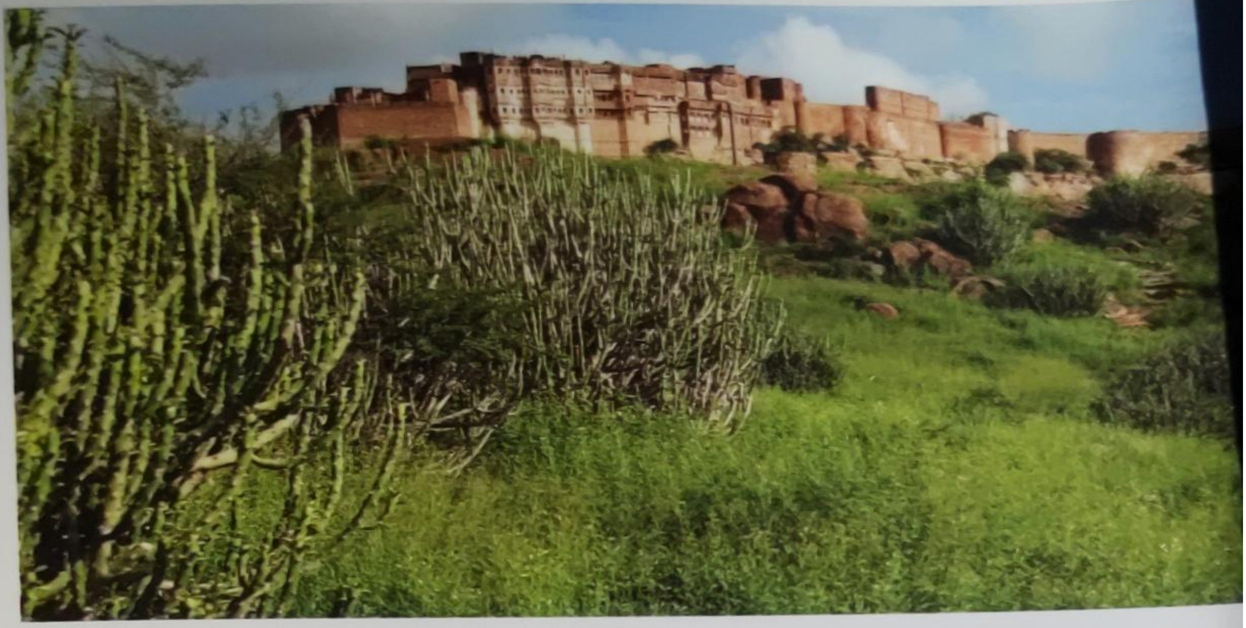
the small

Plant Guide to Rao Jodha

DESERT ROCK PARK

pradip krishen

mehrangarh museum trust



Introduction

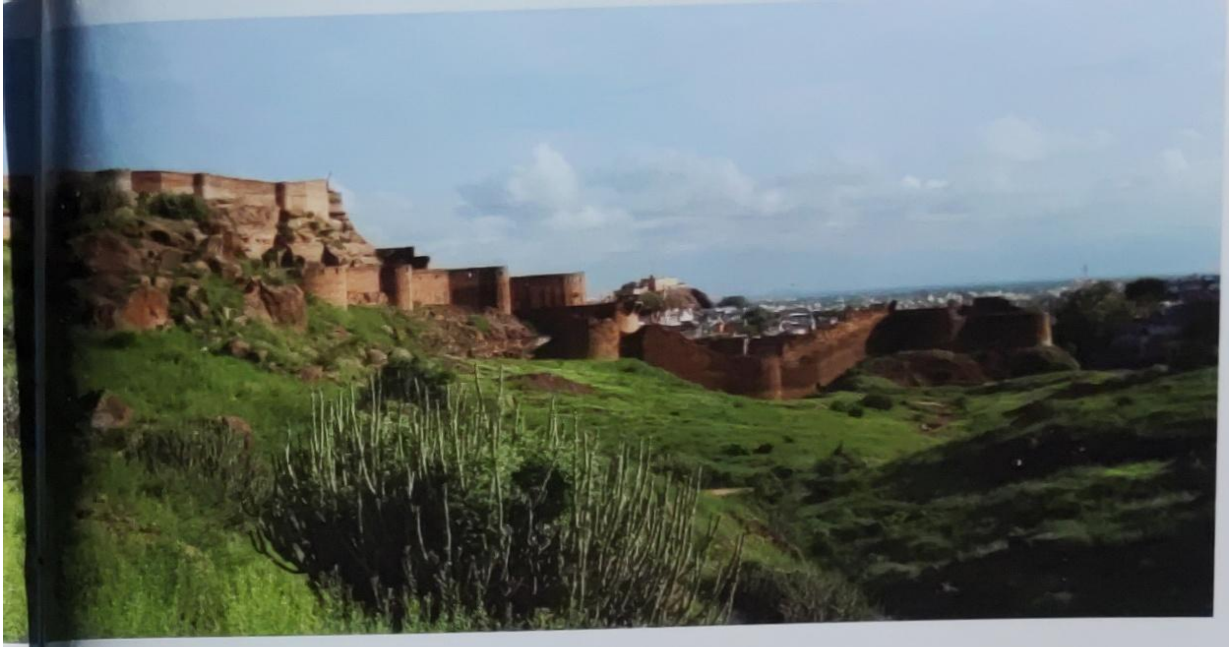
This is a short version of a more comprehensive field guide to the plants of Rao Jodha Desert Rock Park, a little morsel to whet your appetite while the longer version is in preparation. I hesitate to put a number to how many plants we have inside the Park because it goes up with each counting, but a reasonable estimate would be about 300 species of trees, shrubs, climbers and herbs, including grasses and sedges. We feature 42 plants in this Small Field Guide, some of the more common or interesting ones you are likely to see as you walk around the Park.

If you are visiting Rao Jodha Park for the first time, you will probably go through the Visitors Centre and descend into the stormwater gully under the City Wall, which is how we planned the start of our Visitors Trail. Over the next 2 years or so, the Trail will bifurcate and become a network of trails that you can use to explore the Park. This is of course the way we intend our visitors to experience the Park. But it is by no means the only way to walk through the Park and I'm sure there will be some who will read this without ever having travelled to Jodhpur at all. To all of you, wherever you are, welcome to the wonderful world of desert plants from the Thar dryland.

THE HEART OF ROCK COUNTRY

The rock that everyone knows in Jodhpur is Vindhyan sandstone because it is so extensively mined and used. *Everything* in Jodhpur is built with bricks of dressed sandstone. Not so well known is rhyolite, a hard, brittle volcanic rock which makes up the entire hill on the right as you wind your way up to Mehrangarh. It tends to form characteristic long, vertical columns with flat faces and once you notice it, has a signature that allows you to recognize it instantly. Rao Jodha Desert Rock Park is situated on an outcrop of volcanic rhyolite so special that the rock feature has been designated a National Geological Monument.

We began work on the Park early in 2006. Our aim was to try and restore the natural ecology of the rocky tract adjoining Mehrangarh Fort, an area of 70 hectares (about 175 acres). The historic City Wall had been repaired



in 2005 which made it possible to protect the land from foraging animals. If we were successful in bringing back native plants, we imagined that this tract could become an outdoor museum of Marwar's 'lithophytes' – plants specially adapted to living in rocky habitats. We also had a clear sense that 5 or 6 years down the line, we wanted to welcome our first visitors into the Park.

HOW PLANTS ADAPT

Desert plants come in many different forms. Some – the so-called pantropical weeds – are unbelievably hardy, able to cling on somehow in a wide diversity of habitats. But desert rock is a harsh, difficult environment and most plants that are able to survive here have to be specially equipped in some way to deal with extremely low levels of moisture. Rock is even more unforgiving than sand and that is why scientists use a special term – 'lithophyte' – to describe plants that are able to eke out a living in rocky habitats. Rao Jodha Desert Rock Park has one plot of salty sand and some wet areas, so it's not *exclusively* about rock-adapted plants, but in most respects it is a park featuring lithophytes from the Thar desert.

If many of the plants look unfamiliar, it is because the vast majority belong to an ecological province that extends westwards into the great deserts stretching through Pakistan, Afghanistan and the Middle East into north Africa. This is in contrast with the rest of northern and eastern India, whose plants have affinities with northern (trans-Himalayan) or south-east Asian (Indo-Malayan) botanic regions. This makes perfect sense because, above all, plants need to be in tune with their environment. All the evolutionary adaptations that plants need to live here were wrought somewhere in the contiguous swathe of deserts stretching westwards.

Adaptations to desert-living are varied and inventive. Being succulent (able to store water in its tissues) like a cactus, is probably the most useful trick. Thhor (*Euphorbia caducifolia*) is the most prominent succulent of the Thar desert. It does so well, especially growing on rock, that it provides a microhabitat – cool, shady, protected by its spines – that allows many other plants to live within its wide embrace. No surprise then, that we chose thhor as the emblematic plant for our Park.

Lithophytes in the Thar desert are up chiefly against low soil moisture, extremely high daytime temperatures in summer and intense sunlight. Some plants cope with these conditions by developing waxy leaves to reduce vapour loss. Others open their stomata to take up carbon dioxide only at night, when conditions are not so adverse. Many lithophytes grow a coating of fine hairs on leaf surfaces to reflect light and reduce surface temperatures. A few dispense with leaves altogether, assigning the crucial job of photosynthesis to green stems instead. Perhaps the simplest and most elegant adaptation of all is to shorten lifespans and live only in the short 'window of opportunity' when there is moisture in the ground. This is what desert ephemerals do, germinating with the first rains in July, then rushing through flowering and fruit-bearing so that they can disappear just as the soil starts to dry up again. But not before leaving behind hard-coated seeds – tiny time-capsules – that will spring to life when the rains return next year.

Lithophytes grow very slowly – their growing season is extremely short – and we have learned to be happy if we see a young kumatiyo (*Acacia senegal*) that has put on just 15-20 cm of new growth in a single year.

Rao Jodha Park is still a very young refuge for wild plants and it will be some years before you can expect to see mature trees and shrubs. But in the meantime, do pay special attention to the wonderful ephemerals that spring up in the rains. They provide the colour and the verve – the *raunaq* – in our Park.

There is clearly a 'best time' to visit the Park, and a 'less best' time. Late July to October is when the ephemerals are at their best. Some of the hardier ones could still be in flower in December, but by this time most will have made no-nonsense preparations for dropping their seeds and shipping out.

The rest of the year is by no means devoid of interest. Thhor and rohido flower extravagantly in February or March. A number of perennials like kumatiyo burst into flower as soon as the rains arrive. There is usually something or the other going on at all times of the year.

Don't forget to come back in 10 years time! There's quite a few big trees we'd like to show you.

Pradip Krishen
PARK DIRECTOR

Featured Plants

This Field Guide describes 8 trees, 12 shrubs, 18 herbaceous plants and 4 climbers. The wobbly grey numbers to the right of the plant names are plant numbers carved on stone inside the park. We thought this was a good way to label our plants without cluttering the landscape with signs.

TREES 6

Rohido *Tecomella undulata*
Kumatiyo *Acacia senegal*
Hingoto *Balanites roxburghii*
Peeloo *Salvadora persica*
Kharo Jaal *Salvadora oleoides*
Sargooro *Moringa concanensis*
Goondi *Cordia gharaf*
Bordi *Ziziphus nummularia*

SHRUBS 11

Bui *Aerva javanica*
Aakado *Calotropis procera*
Gangeti *Grewia tenax*
Oont Kantalo *Echinops echinatus*
Ghatbor *Flueggia leucopyrus*
Kair *Capparis decidua*
Kheer Kheemp *Sarcostemma acidum*
Kheemp *Leptadenia pyrotechnica*
Thhor *Euphorbia caducifolia*
Dabi *Cadaba fruticosa*
Googal *Commiphora wightii*
Rabad Bel *Cryptostegia grandiflora*

HERBS 20

Vajradanti *Barleria acanthoides*
Peelo Vajradanti *Barleria prionitis var. dicantha*
Kakori Booti *Ruellia patula*
Melhania *Melhania magnifolia*
Chirki *Pavonia arabica*
Seddera *Seddera latifolia*
Jungli pyaaz *Drimia indica*
Missi *Striga gesnerioides*
Geedar Tambaku *Verbascum chinense*
Jalbooti *Phyla nodiflora*
Dhamaso *Fagonia indica*
Bekario *Indigofera cordifolia*
Pindru *Lindenbergia muraria*
Oont kanalo (2) *Oligochaeta ramosa*
Jungli gobi *Launaea procumbens*
Ghamra *Tridax procumbens*
Kunden *Heliotropium ovalifolium*
Ringani *Solanum virginianum*

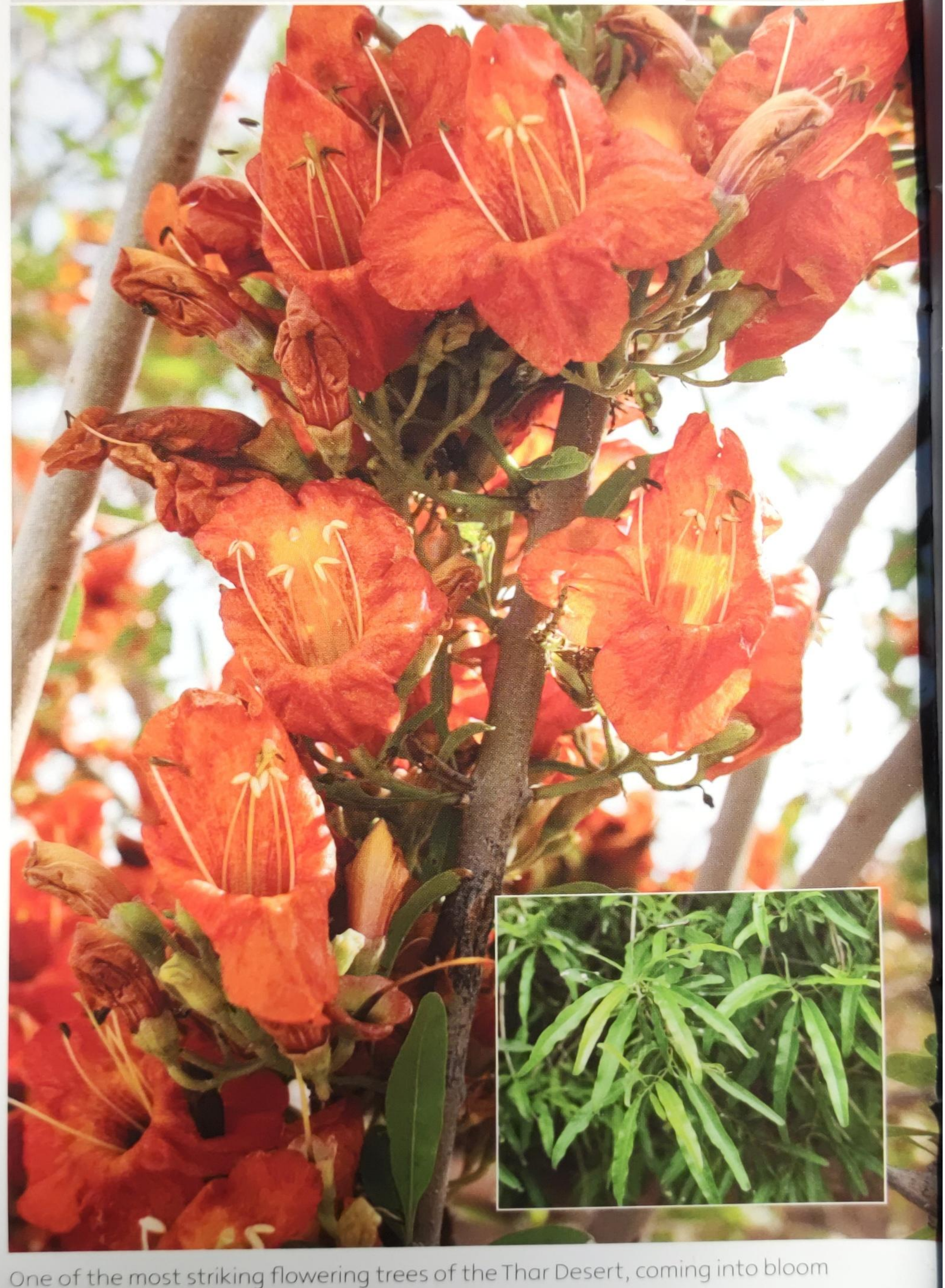
CLIMBERS 30

Santari *Ipomea pes-tigridis*
Orapa *Maerua oblongifolia*
Peelvaan *Cocculus pendulus*
Rota Bel *Rivea hypocrateriformis*

rohido desert/marwar teak

Tecomella undulata | FAMILY Bignoniaceae

HABITAT Sandy plains and valleys ✿ FEB–MAR



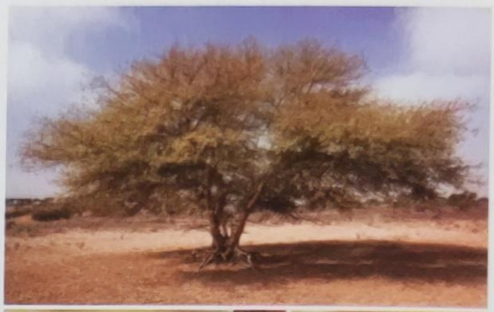
One of the most striking flowering trees of the Thar Desert, coming into bloom at a time when most other trees in the desert are still dormant in late winter or early spring. The flowers vary from deep yellow to vibrant orange. Rohido is prized for its close-grained timber which makes one of the best carving woods in India. This tree features in the Red Data Book of India's endangered plants but is still fairly easy to spot in sandy places when you drive through Marwar.

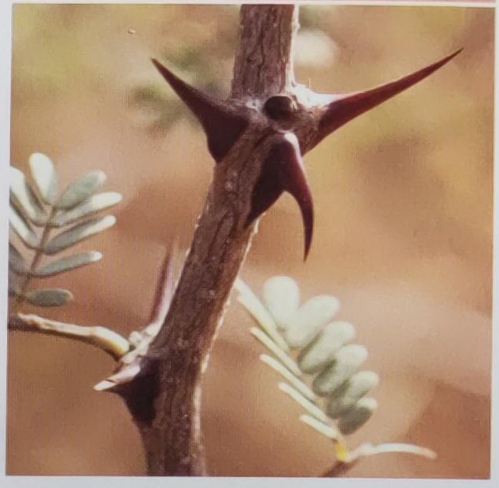
kumatiyo gum arabic tree 2

Acacia senegal | FAMILY Mimosaceae

HABITAT Dry, rocky hills and gravelly plains ✿ JUL–AUG

A small, thorny tree superbly adapted to growing in dry, rocky places in the desert. Kumatiyo starts putting on new growth with the first showers of the monsoon and is quickly covered by white bottlebrush-shaped flowering spikes. This is the only desert acacia with spines arranged in sets of 3 – the 2 outer ones only slightly curved, the middle spine strongly hooked. Flat, pale brown pods decorate the tree in early winter and the seeds are collected when still green to make a Marwari vegetable. This tree is the source for gum arabic used in processed food. Kumatiyo's native range stretches right across the middle eastern desert into Arabia and Senegal.



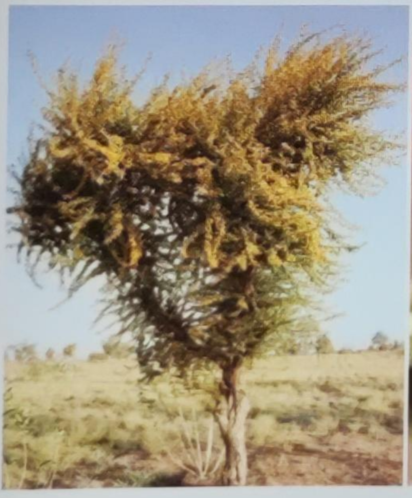


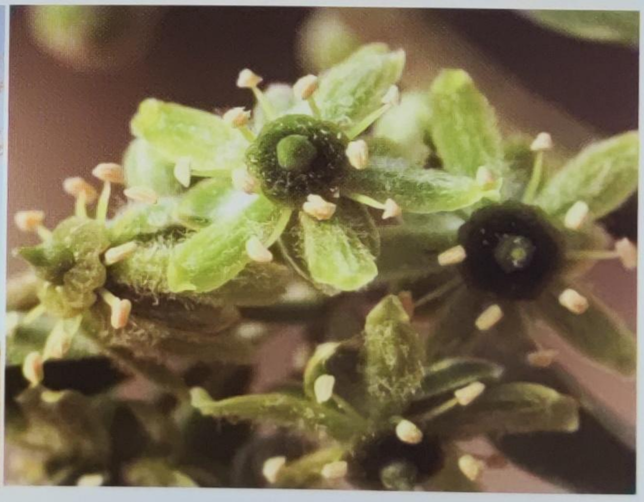
---

hingoto desert date 8

Balanites roxburghii | FAMILY Balanitaceae

HABITAT Sand, clay or gravel ✿ APR–MAY





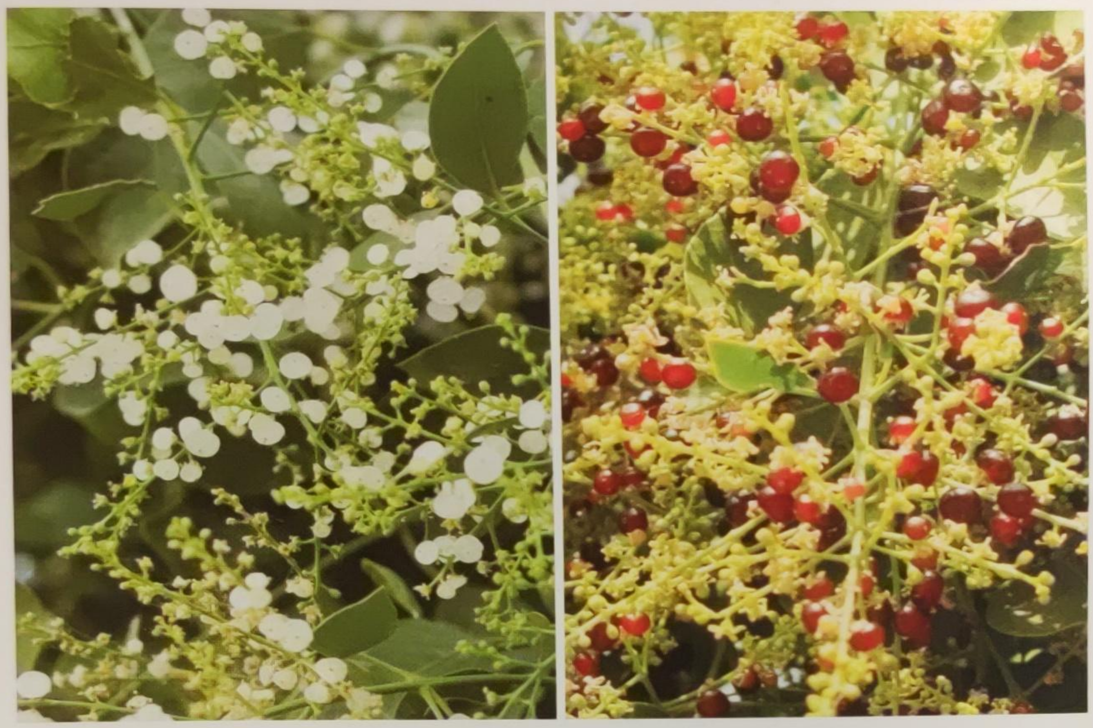
Hingoto (also: hingua, hingorni) is a smallish tree with stiff, green twigs and stout leaf-bearing thorns. The curious, furry flowers appear early in summer and turn into woody fruit filled with a somewhat unpleasant smelling pulp that is relished by wild animals like the neelgai, porcupine and jackal. Another traditional use for the pulp – now very rarely employed – is for cleaning silk. Hingoto spreads rapidly by root-suckers and is often seen growing in clumps at the edges of sandy fields or in road cuttings.

peeloo toothbrush tree

24

Salvadora persica | FAMILY Salvadoraceae

HABITAT Wastelands, marshy places ✿ DEC–APR



Desert trees of great character with knobbly trunks and a dark canopy of fleshy leaves. Peeloo (also: meettha jaal, dhalu) is found in a vast arid territory stretching west to Arabia and is thought to be the 'Mustard tree' of the Old Testament. The small, peppery berries come in colours ranging from bright ruby red to white. The miniscule greenish-yellow flowers are easily overlooked.

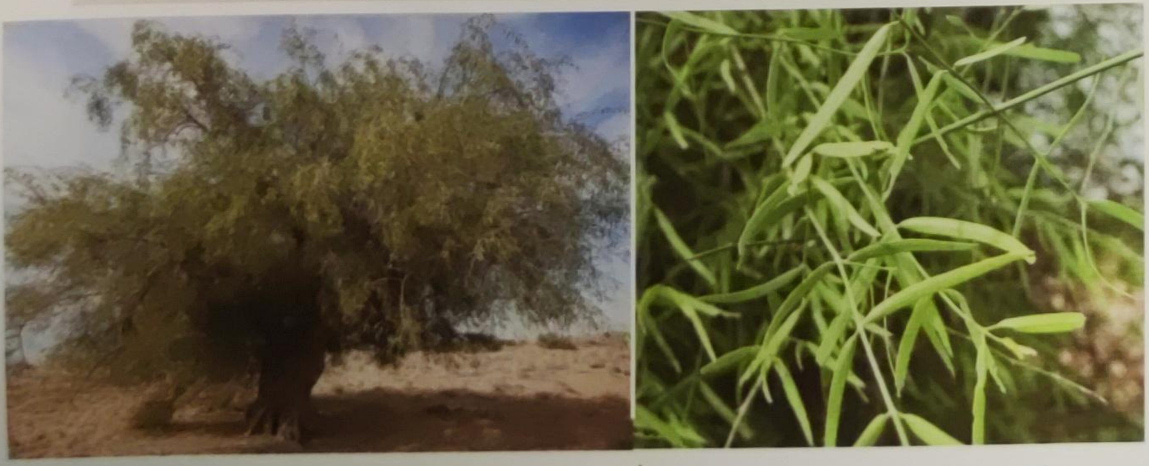
---

kharo jaal olive-leaved salvadora

25

Salvadora oleoides | FAMILY Salvadoraceae

HABITAT Sandy plains, also rocky ground ✿ MAR–APR



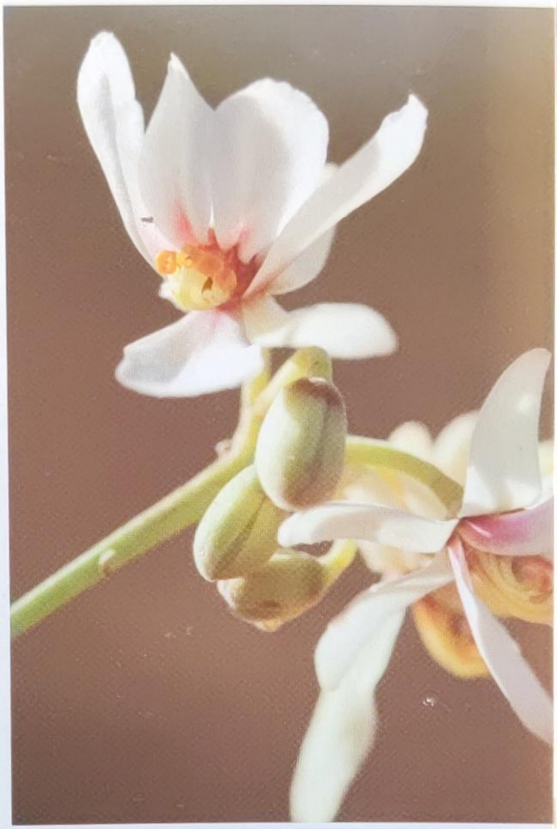
This salvadora usually grows in seasonal watercourses and rocky depressions. Its slim, graceful, olive-like leaves are unmistakable but so is the dense canopy which often droops right down to the ground hiding its bole altogether. The trunk is even more gnarled and wonderful than peeloo's and offers refuge to many small creatures within its corrugated folds and hollows.

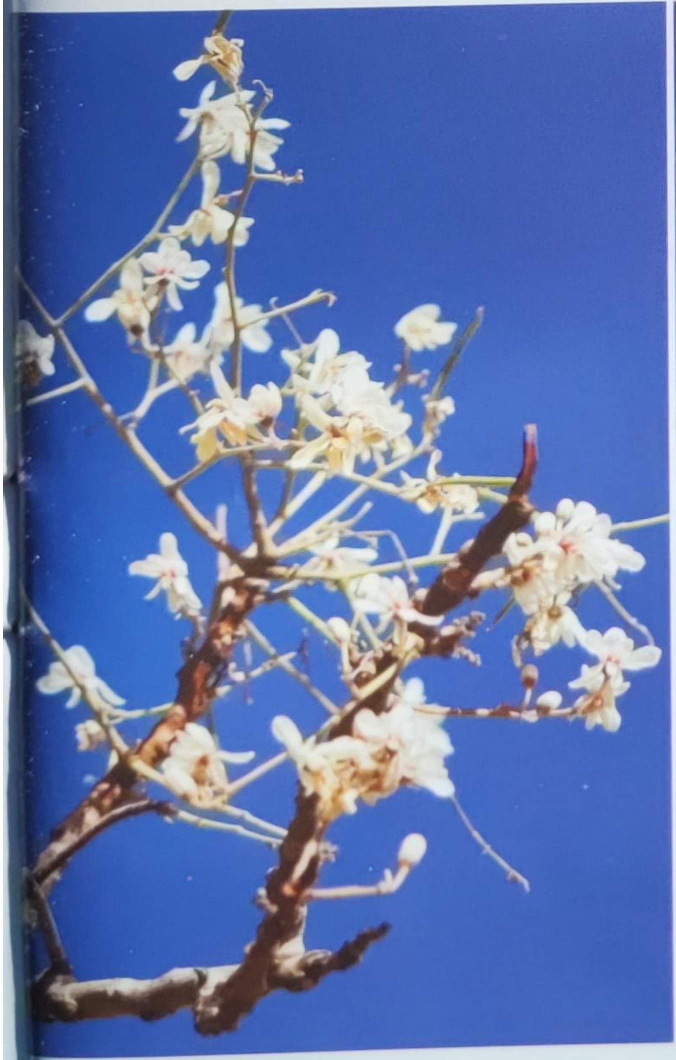
sargooro bitter drumstick tree

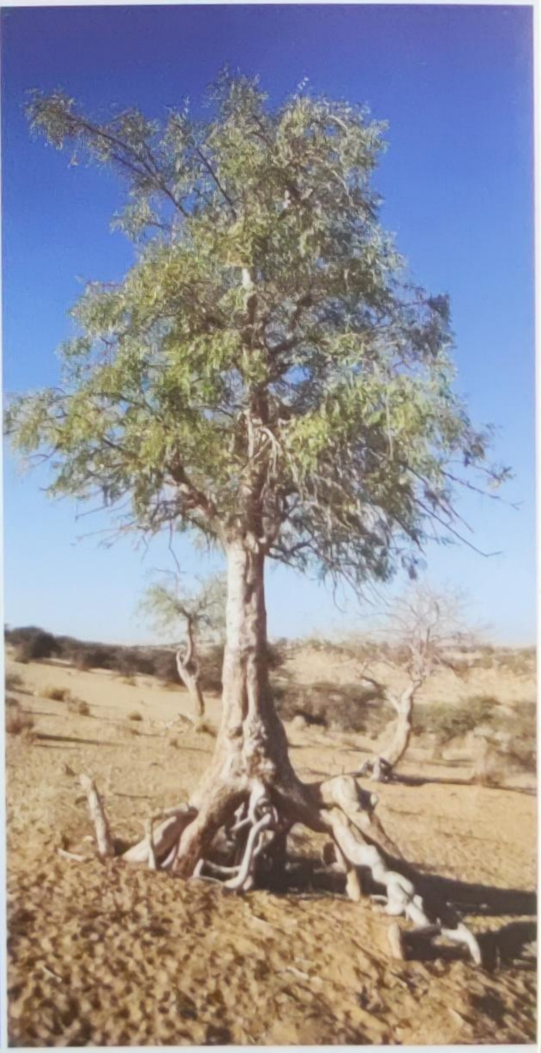
Moringa concanensis | FAMILY Moringaceae

HABITAT Sandy dunes and rocky hills ✿ NOV–JAN

An unmistakable relative of the sonjna or drumstick tree, only wilder and capable of taking you completely by surprise when you see it in unlikely places in the desert. It looks a lot like sonjna with its much-divided ferny leaves, luminously pale green when they first appear. Its roots will alert you to the difference, for sarguro survives by growing enormous roots that anchor it in sand dunes and penetrate gravelly ground. This is surely one of the most beautiful wild trees of the Thar desert. Its white flowers – like little birds with their wings drawn back, about to take flight – are pink-tinged, but the fruit is bitter and is not eaten.





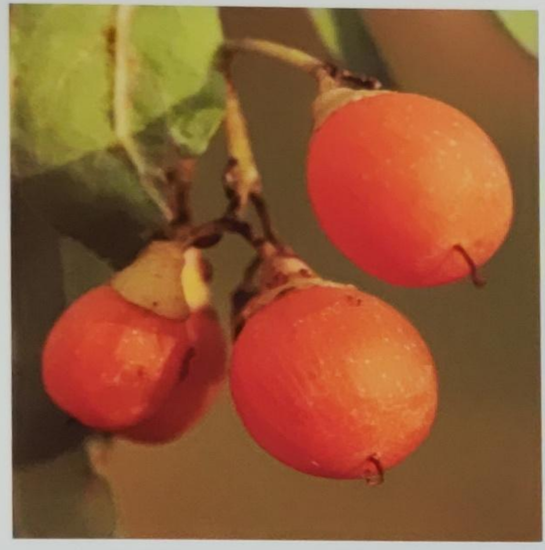


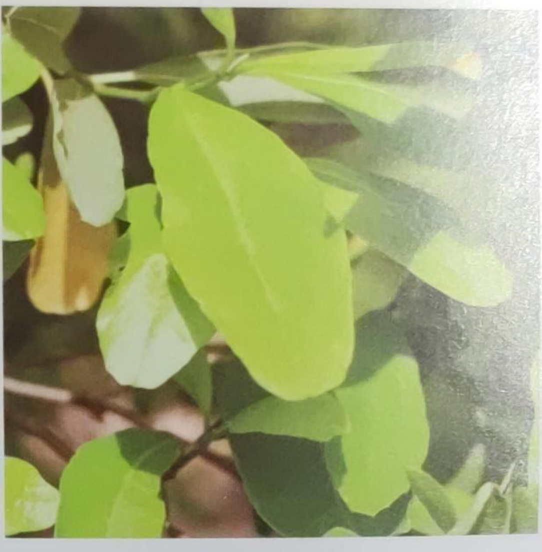
goondi narrow-leaved sepistan

17

Cordia gharaf | FAMILY Ehretiaceae

HABITAT Rock and sand ✿ MAY–JUN





A smallish tree to about 5 or 6 m, common in dry forests and on bouldery hills. Hardy and adaptable, goondi (also: gundani, lasoodi) produces small orange berries that are sold in the marketplace as rude food. The seeds are embedded in a gelatinous pulp. When chewed, goondi bark stains the mouth red and children sometimes use it to look adult and mimic the effect of chewing *paan*.

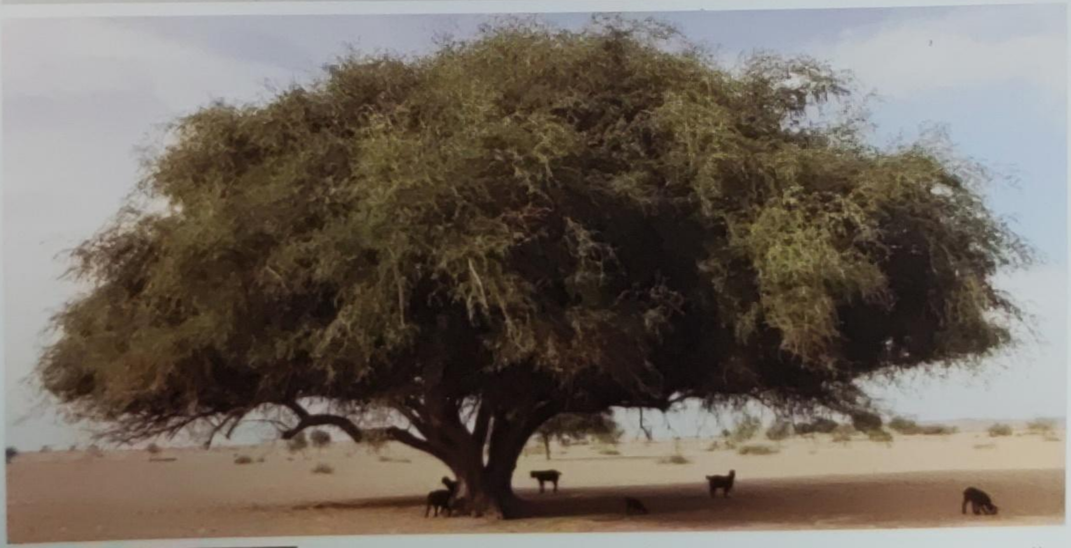
---

bordi jujube bush

30

Ziziphus nummularia | FAMILY Rhamnaceae

HABITAT Sandy plains ✿ AUG–OCT



In most parts of India, bordi (also: jhadber) is just a small, straggling bush but seems to relish desert conditions and flourishes in protected *orans* where it can grow to 7 or 8 m with a great, tangled, bushy crown. Like other plants in its genus, bordi is intensely thorny with one of its pair of spines straight, the other hooked. The fruits have a dry, mealy flesh that hardly seems worth the trouble to eat.

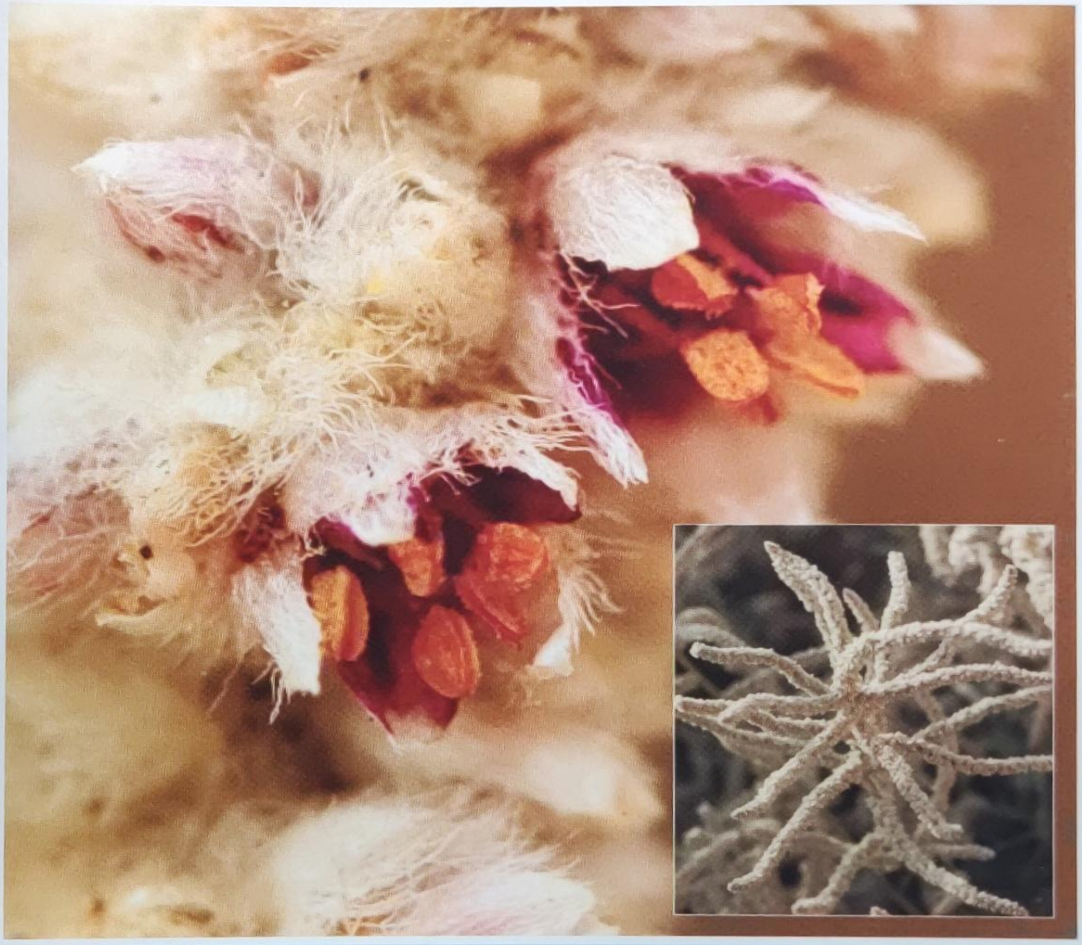
bui desert cotton

59

Aerva javanica | FAMILY Amaranthaceae

HABITAT Sandy areas ✿ SEP–JAN

One of the most common desert shrubs, superbly adapted to growing in deep sand. Bui (also: buari) has cottony flowers and fruit and sometimes covers large expanses following lines of natural drainage. Bui ranges widely in sandy deserts in Africa and the middle-east and has colonized northern parts of the Australian desert too. Bui cotton is used by desert people to stuff mattresses and pillows.

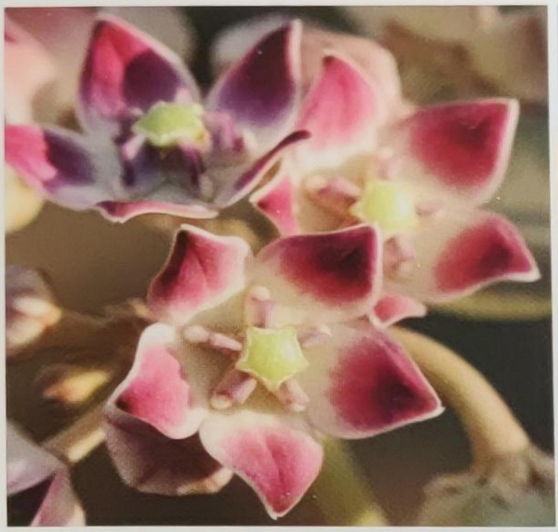


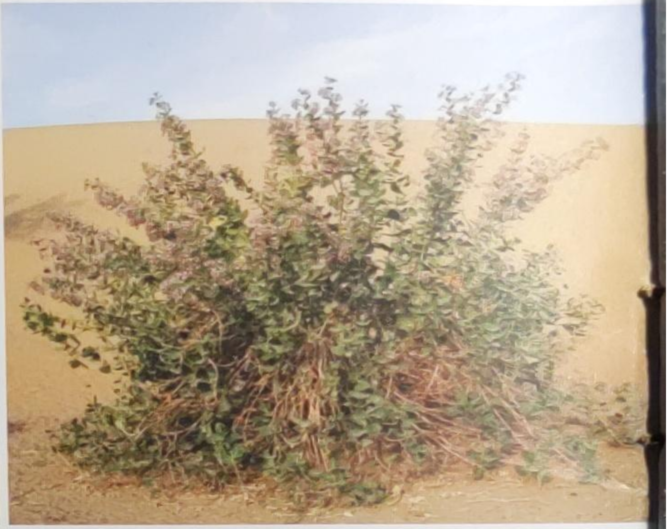
aakado giant milkweed

58

Calotropis procera | FAMILY Apocynaceae

HABITAT Sandy plains ✿ ALL YEAR





A large bush or less commonly a small tree upto 4 m tall with pretty flowers, very common in some parts of the desert. Aakado (also: aak) likes disturbed soil (such as abandoned fields) where it can form nearly pure colonies especially in salty sand. Aakado fruits yield a fibre that finds many uses for desert folk.

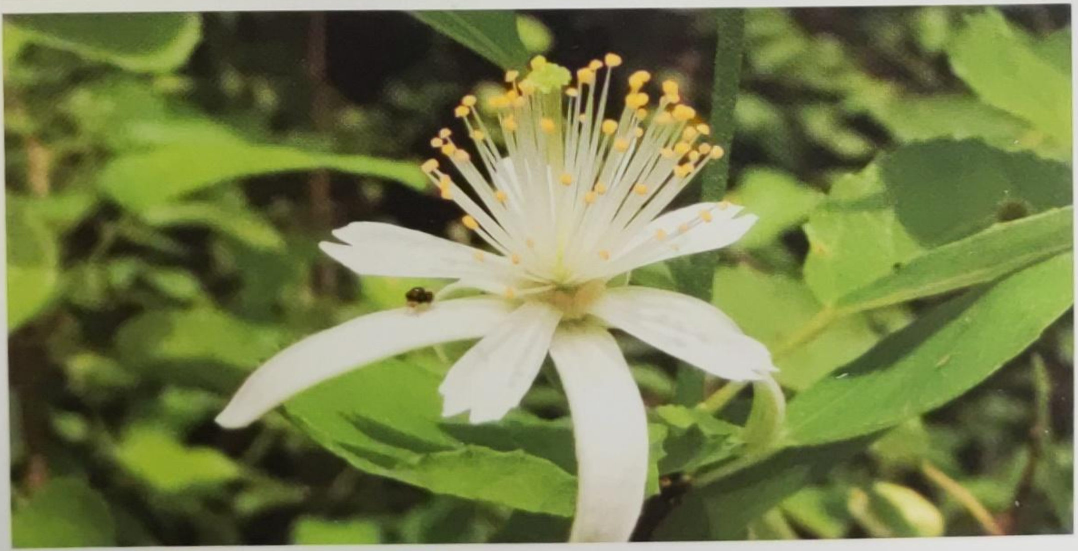
---

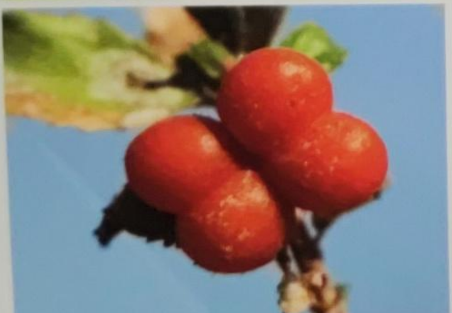
gangeti white crossberry

69

Grewia tenax | FAMILY Tiliaceae

HABITAT Rocky hills, ravines ✿ JUL–SEP





Gangeti (also: gangerun) is a tall, leggy, somewhat untidy shrub upto about 2 m tall that survives surprisingly well in rocky, inhospitable places in the desert. Its small white flowers stand out but the best way of recognizing it in the wild is by its bright orange fruit, usually 2-4 berries joined together. The fruits are edible, but only just.

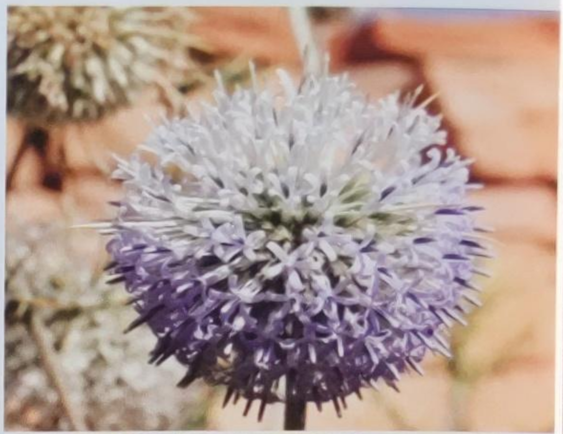
oont kantalo globe thistle

67

Echinops echinatus | FAMILY Asteraceae

HABITAT Sandy plains, rock | ✿ DEC–MAR

A characteristic thistle from the daisy family though you have to peer quite closely past its spines to see tiny, blue flowers arranged in a compound head. Oont kantalo can grow nearly a metre tall and colonizes small tracts, especially sandy or rubbly wastelands. Its leaves are deeply divided into long, thin segments each of which ends in a spine.

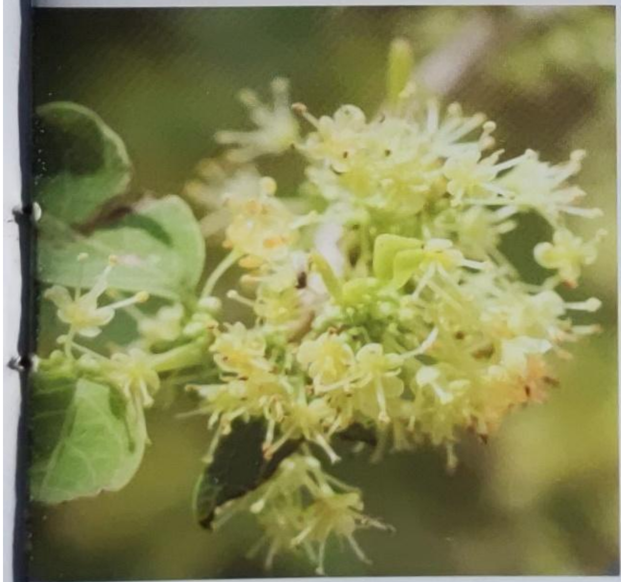


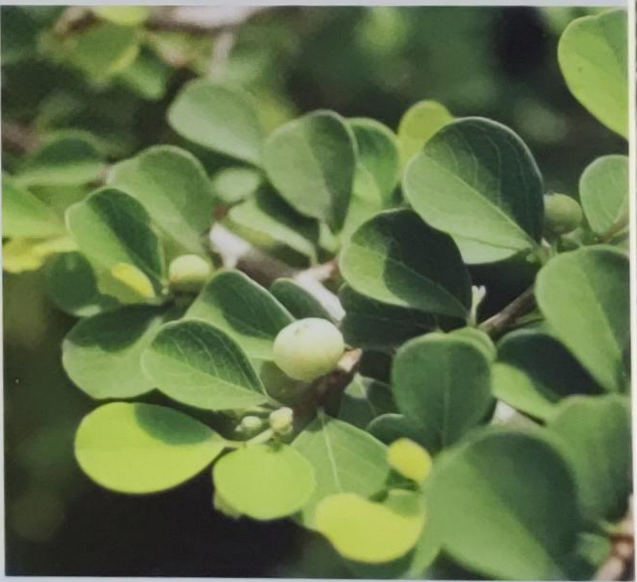
ghatbor bushweed

80

Fleuggia leucopyrus | FAMILY Phyllanthaceae

HABITAT Rocky hills, ravines | ✿ JUL–AUG





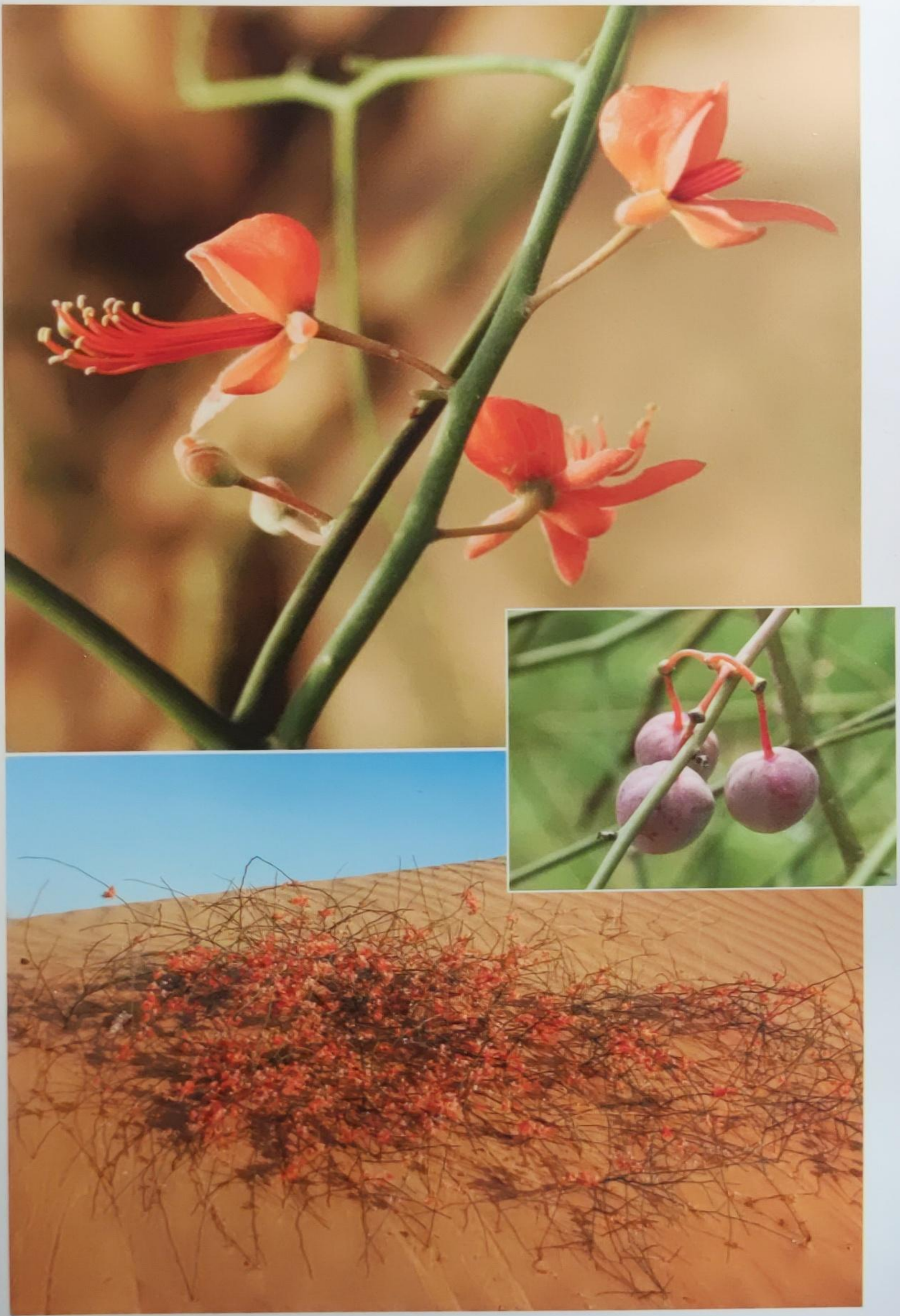
Ghatbor is a large, long-limbed shrub with attractive, orbicular leaves. It reaches its greatest size near water but does not mind making a niche on dry, rocky ground. The flowers are tiny, pale yellowish, both males and females produced in great profusion on separate plants. The fruits (only on female plants, of course) are white, spherical, only about 4 mm in diameter.

kair bare caper

59

Capparis decidua | FAMILY Capparaceae

HABITAT Sandy or rocky places ✿ APR–MAY, SEPT–OCT



A spiny bush or small tree with a dense mop of wiry, green, leafless branches, one of the emblematic plants of the Thar desert. Kair (also: kerro, teent, dela) leaves are tiny and quickly shed, part of a strategem to deal with extreme drought. Twice a year, kair produces masses of bright orange flowers that make a very pretty sight. The dark pink fruits are pickled or cooked as a vegetable.

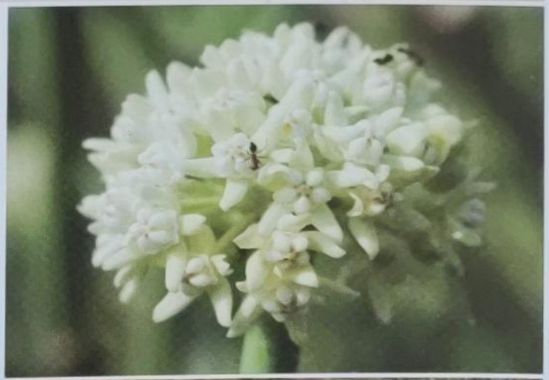
kheer kheemp

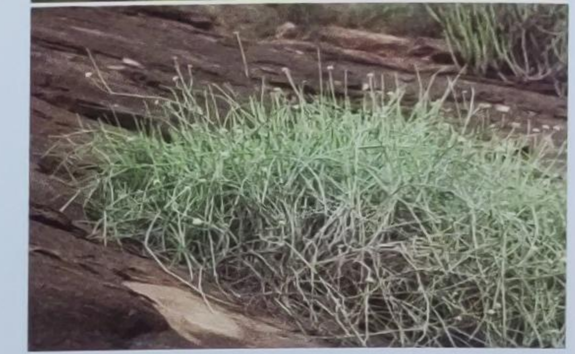
79

rambling milkweed

Sarcostemma acidum | FAMILY Asclepiadaceae

HABITAT Dry rocky places ✿ JUL–AUG





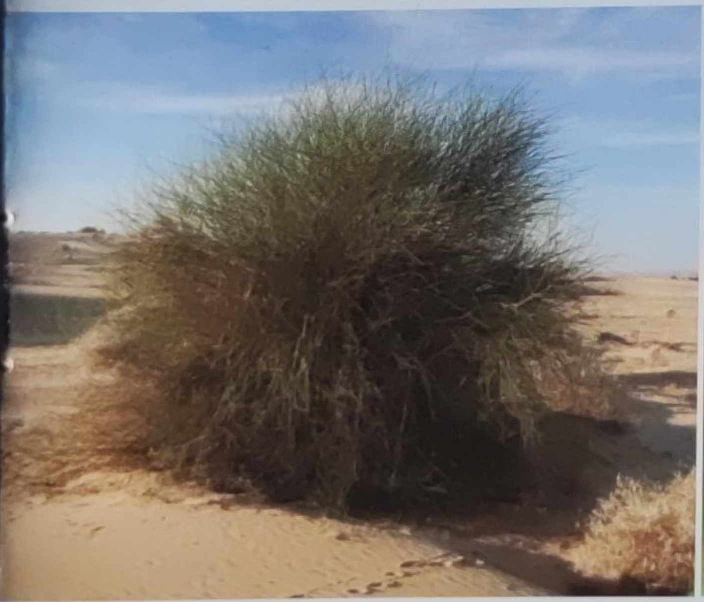
A rambling shrub full of milky latex with smooth, jointed branches and no leaves at all. Doing without leaves altogether is an adaptation that quite a few desert plants use to cut down on water-loss from leaf-surfaces. The essential work of photosynthesis is done by chloroplasts in green stems. Kheer kheemp (also: khursani tanto, art thhor) produces its white flowers at the butt-ends of flexuose twigs. The flowers have a delicious fragrance that is most intense at night and early in the morning. Kheer kheemp likes rocky hillsides and outcrops.

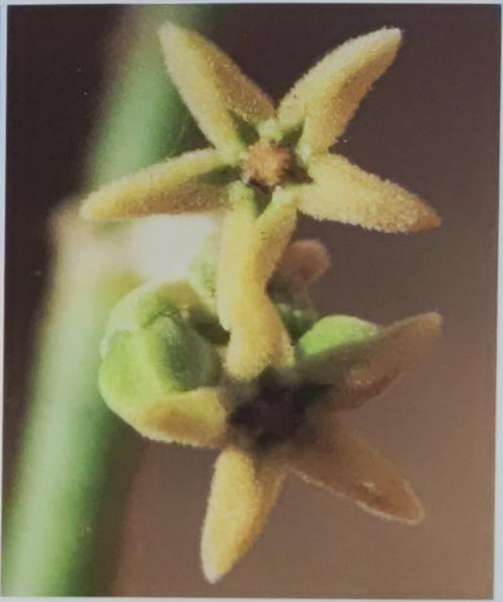
kheemp broom brush

74

Leptadenia pyrotechnica | FAMILY Apocynaceae

HABITAT Sandy places ✿ SEP–DEC





A large, thin-stemmed bush up to 2.5 m high, beautifully adapted to living in dry, deep sand. Kheemp has slender leaves on stems packed with milky latex, and desert folks use the dried stems for thatching and to make brooms. The tiny flowers are velvety-hairy and resemble sea creatures more than anything else!

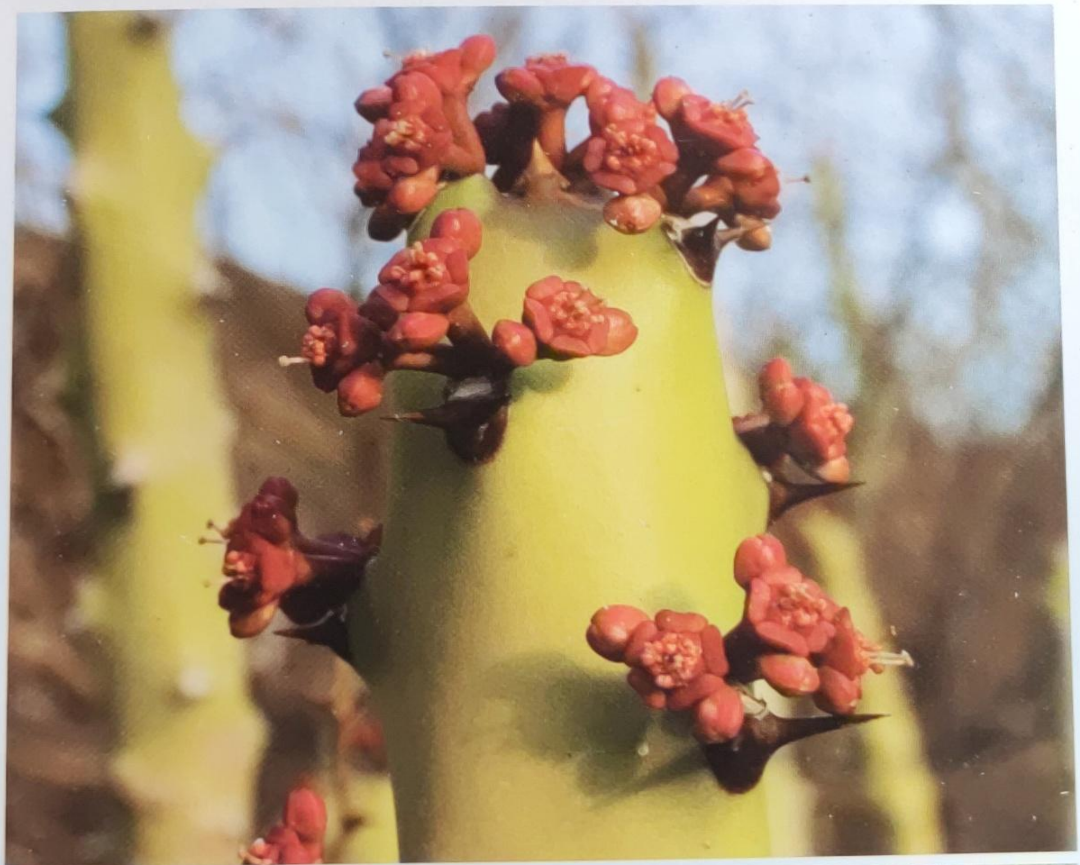
thhor leafless spurge

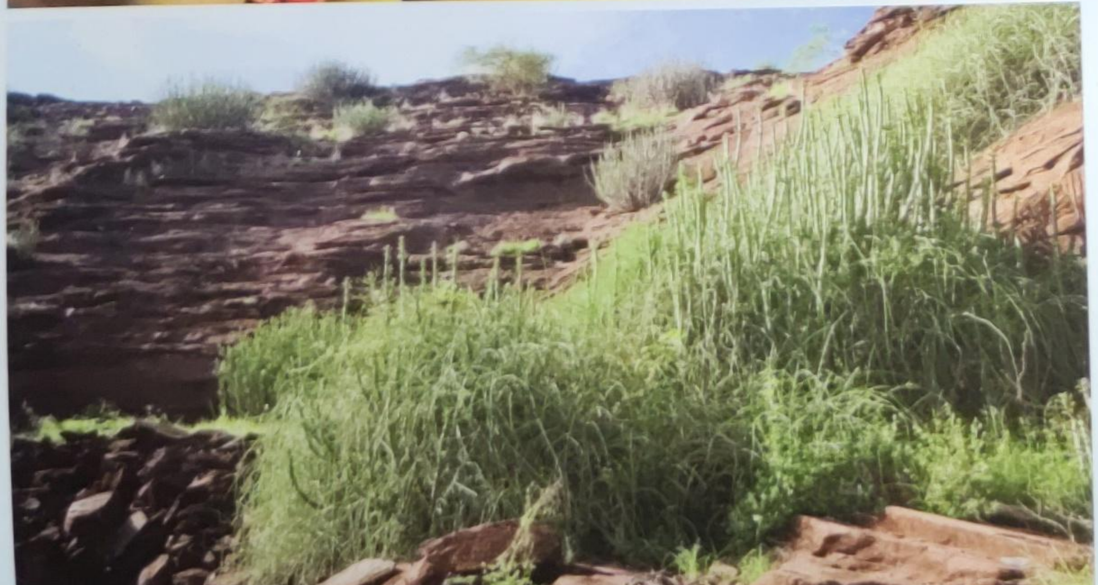
68

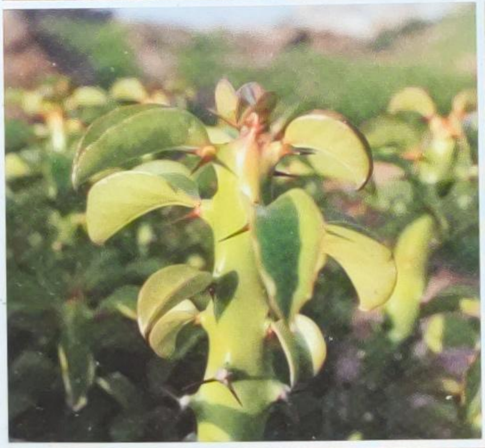
Euphorbia caducifolia | FAMILY Euphorbiaceae

HABITAT Rocky areas, gravel plains ✿ JAN–MAR

A tall, multi-stemmed, cactus-like succulent that is a reliable indicator of rocky or gravelly substrates in the Thar desert and is one of its emblematic plants. Despite its English name, thhor (also: danda thhor) puts forth fleshy leaves at the tops of its stems for a short while at the height of summer. There are 2 forms of flowers – most commonly bright red but also green, with intermediate colours of red or pink. The flowers themselves are borne on curious structures that are peculiar to the very large and diverse spurge family (*Euphorbiaceae*). Thhor is a vitally important component of the desert flora. Because it is large, offers shade and protection (by its thorns), it often becomes a miniature ecological niche in itself, supporting a host of other plants and small creatures like rodents and lizards.







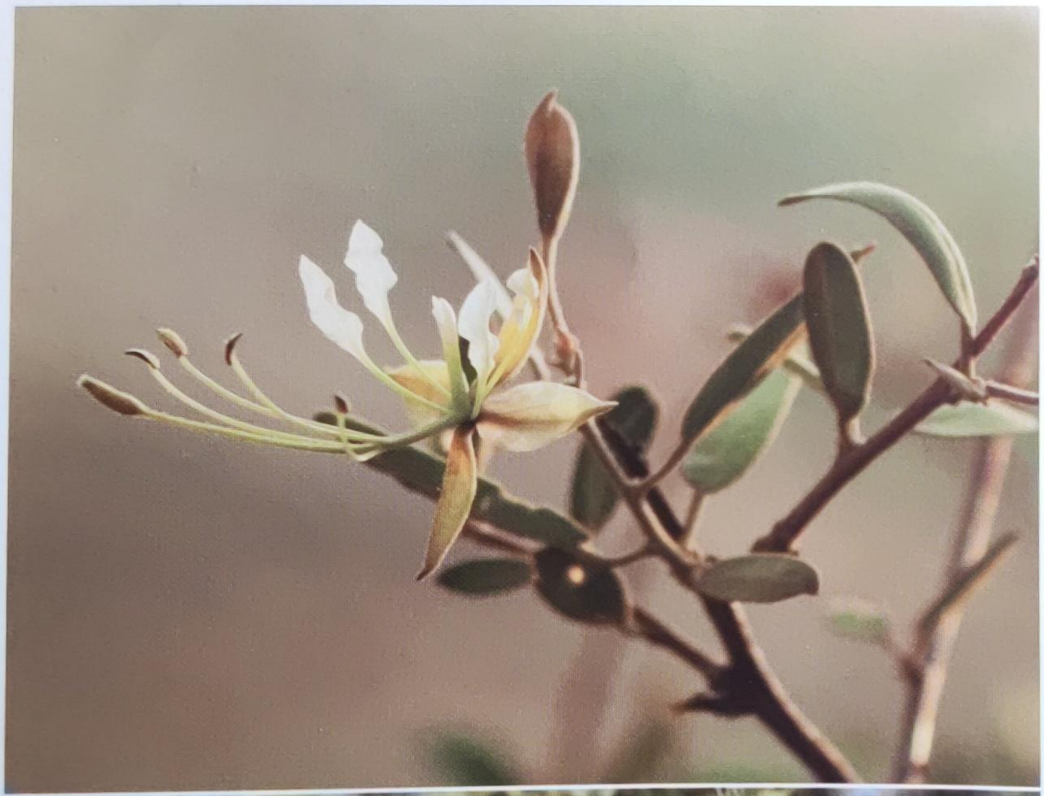
dabi indian cadaba

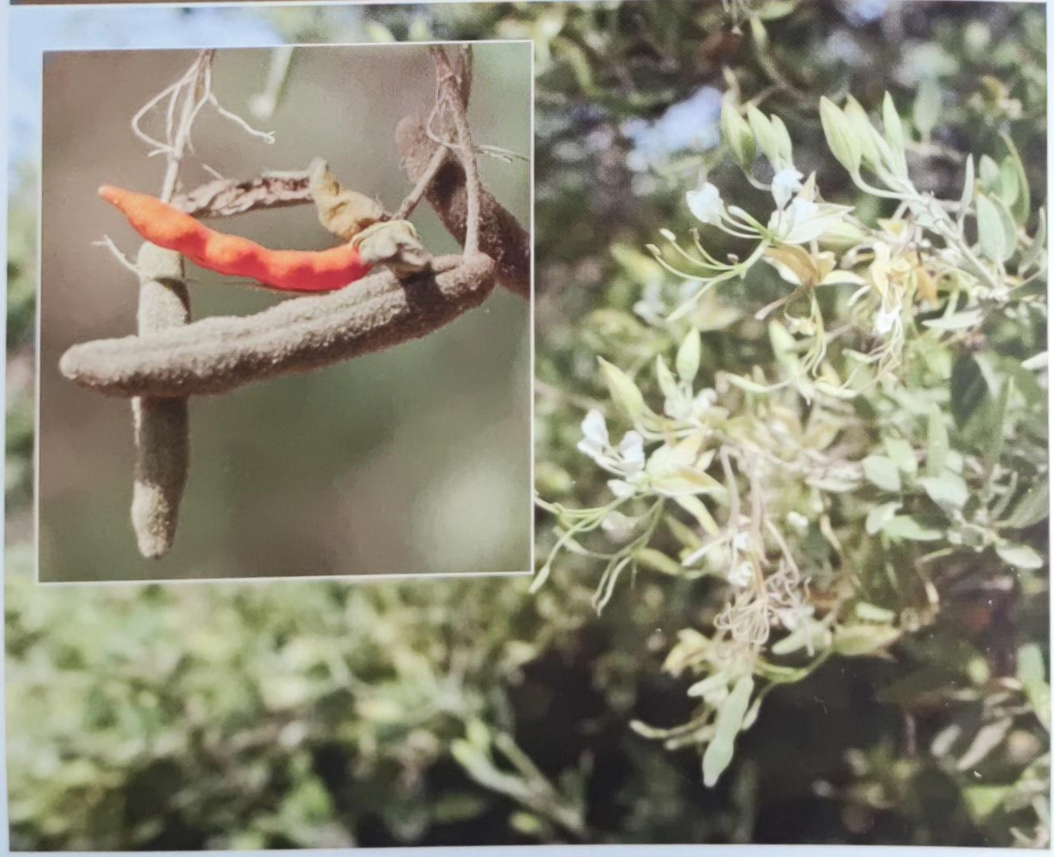
56

Cadaba fruticosa | FAMILY Capparaceae

HABITAT Sandy/rocky places ✿ DEC–MAR

A dense, rambling shrub from the caper family that arrests attention when it is in flower. Its pale white, delicate petals have long claws and a little tube-like structure in their midst. The ovary is borne at the end of a long stalk, like with many other plants in this family. Dabi fruit are cylindrical, about 2 cm long, with a mealy jacket that peels back to reveal a surprisingly bright orange inner covering.





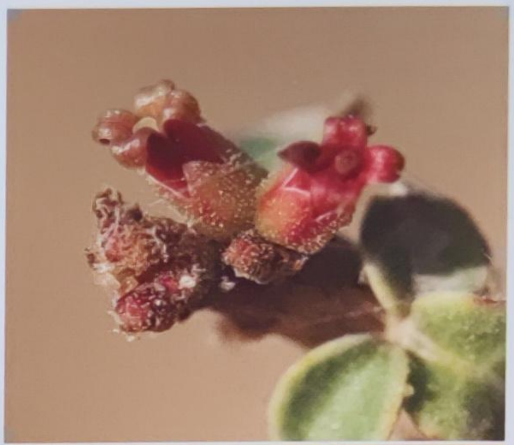
googal mukul myrrh

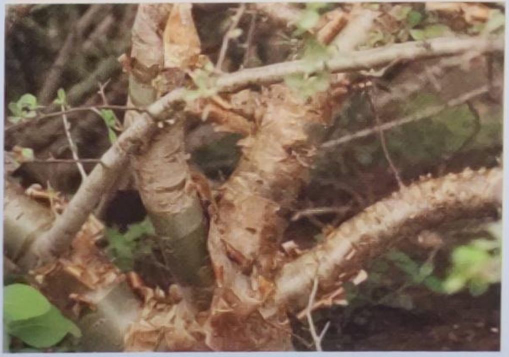
62

Commiphora wightii | FAMILY **Burseraceae**

HABITAT **Dry rocky hills** ✿ JAN–FEB

Googal is the most valuable medicinal plant of the Thar desert, overexploited and now becoming rare because of its reputation in Ayurvedic medicine. It is in the Red Data List of endangered plants. Googal forms a low, stout, thorny shrub or rarely, a small tree with characteristic shiny, peeling bark and tiny red flowers. Googal's most important feature is its resinous sap known as 'Indian bdellium' or 'gum googal' which exudes from its trunk in the cold season. Ayurveda uses a steroid extract of this resin to make a medicine that is supposed to lower cholestrol. Gum googal releases a myrrh-like fragrance when burned over a naked flame and sells in a form known as 'dhoop' in Indian bazars.





---

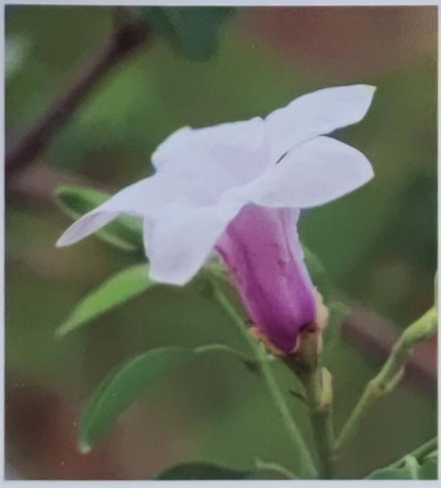
rabad bel

rubber vine / purple allamanda

64

Cryptostegia grandiflora | FAMILY **Periplocaceae**

HABITAT **Dry habitats near water** ✿ ALL YEAR

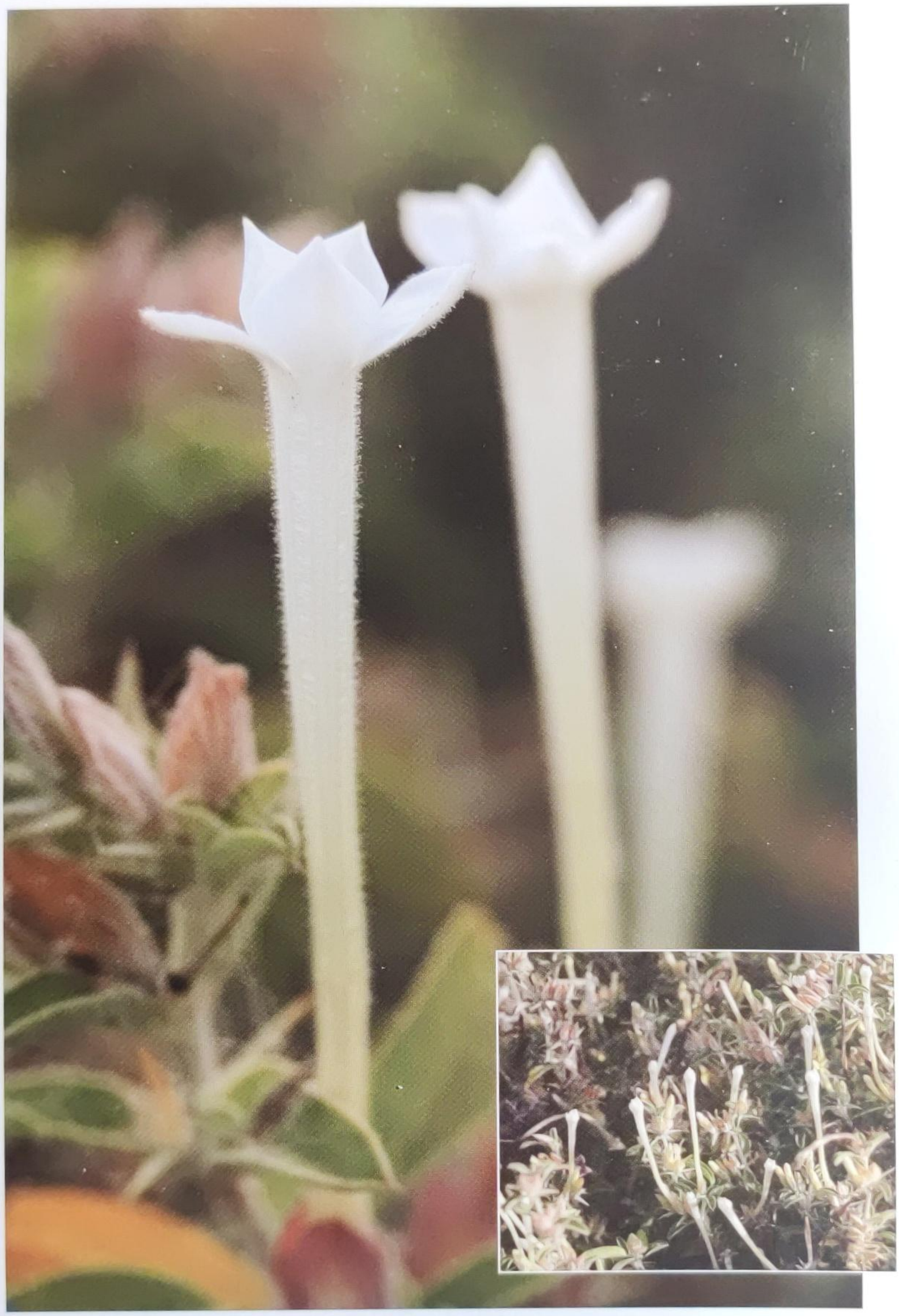


An evergreen climbing shrub with milky latex and pretty, pale pink flowers, native to Madagascar. Rabad bel (also: vilaiti aakado) was introduced into India around World War I as a source of rubber for airplane tyres but interest quickly waned when efforts to tap its latex proved uneconomical. It has since run wild in dry parts of India and has taken up residence close to water. We feature it in Rao Jodha Park as a curiosity and try and ensure it does not become invasive!

vajradanti spiny white barleria 134

Barleria acanthoides | FAMILY Acanthaceae

HABITAT Rocky plateaux in Marwar ✿ AUG–NOV



A low, spiny bush with pure white, long-tubed flowers that open at dusk and lie flat and spent when you see them in the morning. Pale brown leafy bracts with delicate veins are positioned on either side of the flowers and at dry times of the year when most leaves are under stress, these bracts form the most conspicuous part of the plant. Vajradanti (also: chapari) is found in rocky parts of the desert westwards through the middle-east as far as N Africa.

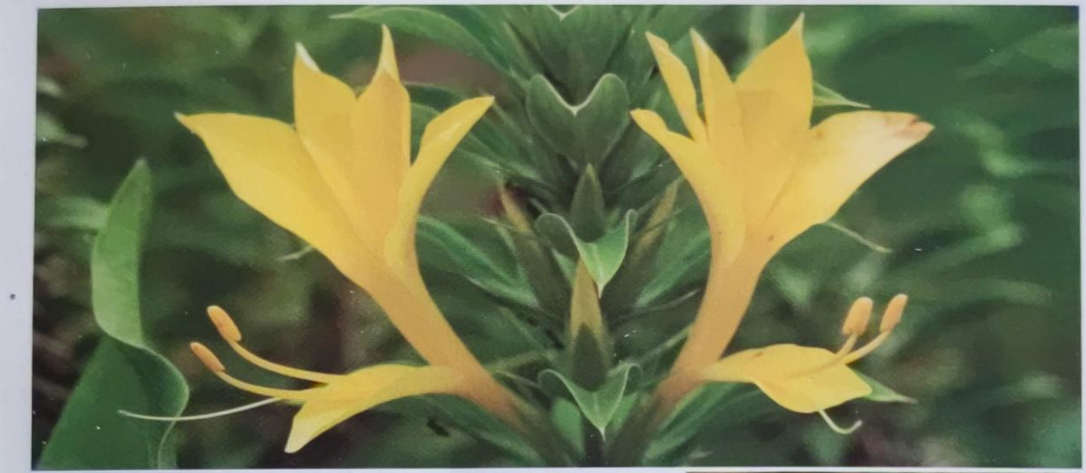
peelo vajradanti

porcupine flower

135

Barleria prionitis var. dicantha | FAMILY Acanthaceae

HABITAT Rocky hillsides ✿ SEP–JAN



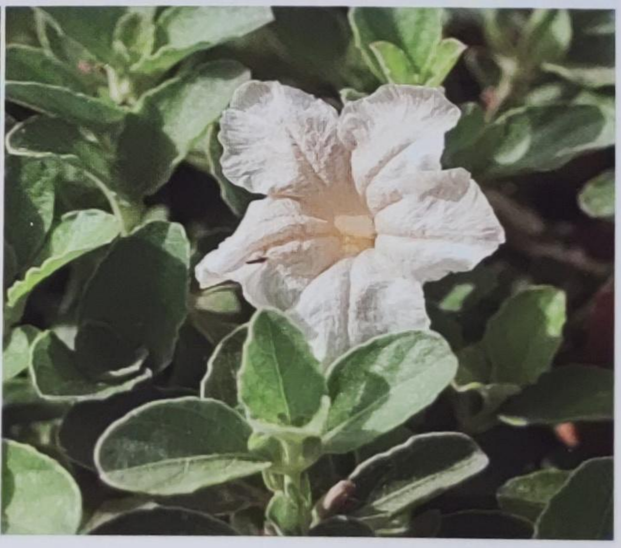
This barleria is endemic to Marwar and has been seen only in a few places in Barmer district. It has larger, more profuse flowers than the common variety *prionitis* and seems more at home in rugged, rocky hillsides. Peelo vajradanti often seeks refuge inside large thhor bushes, taking advantage of the cool microhabitat they provide.

kakori booti desert petunia

173

Ruellia patula | FAMILY Acanthaceae

HABITAT Rocky areas, wastelands ✿ JUL–OCT



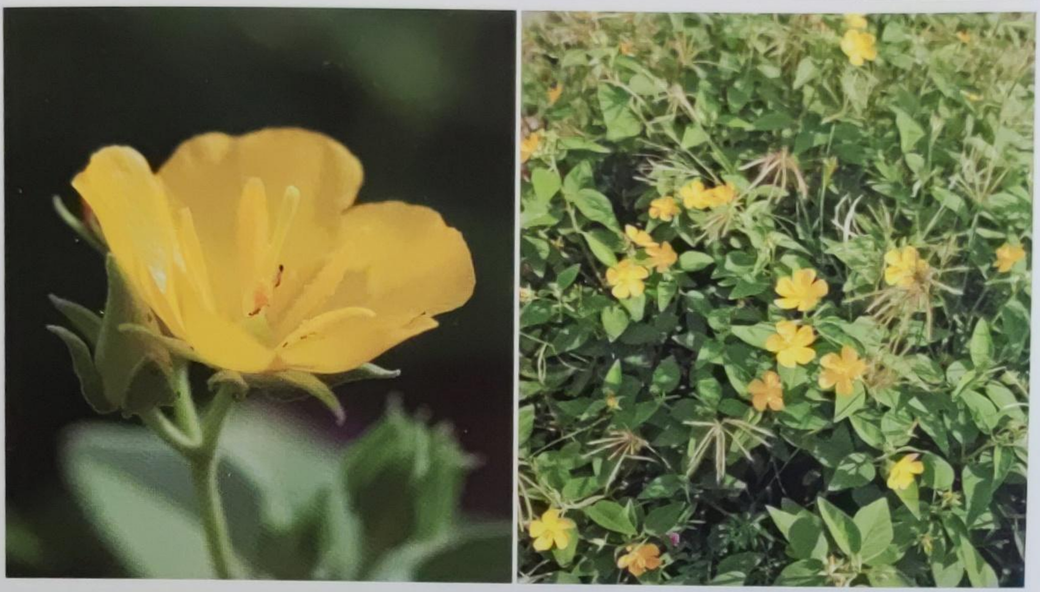
Like vajradanti, the pure white flowers of kakori booti open at dusk and the plant looks devastated when you see the flowers lying on their sides en masse in the morning. Most white flowers in the wild are pollinated by night-flying moths so it makes perfect sense that the flowers become redundant as soon as darkness lifts. Kakoori booti is found in dry, rocky places in the desert west to Africa.

melhania (no local or common names)

196

Melhania magnifolia | FAMILY Malvaceae

HABITAT Sandy or rocky sites ✿ ALL YEAR



Melhania is an outstanding genus of flowering undershrubs from desert habitats and it is strange that the plants are not better known or cultivated. This species – one of 3 Melhanias in Marwar – has a curious habit of opening its lovely flowers at about 4 pm – varying a bit with the seasons, of course.

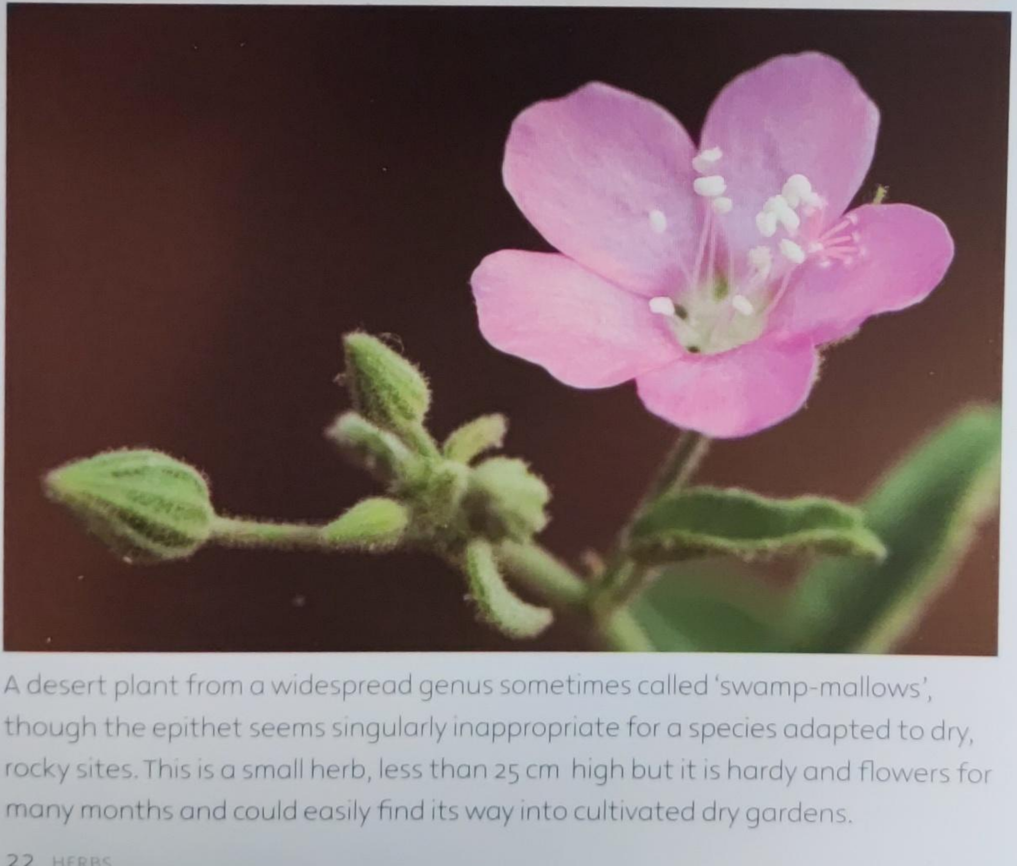
---

chirki (no common names)

203

Pavonia arabica | FAMILY Malvaceae

HABITAT RSandy or rocky sites ✿ JUL–OCT



A desert plant from a widespread genus sometimes called 'swamp-mallows', though the epithet seems singularly inappropriate for a species adapted to dry, rocky sites. This is a small herb, less than 25 cm high but it is hardy and flowers for many months and could easily find its way into cultivated dry gardens.

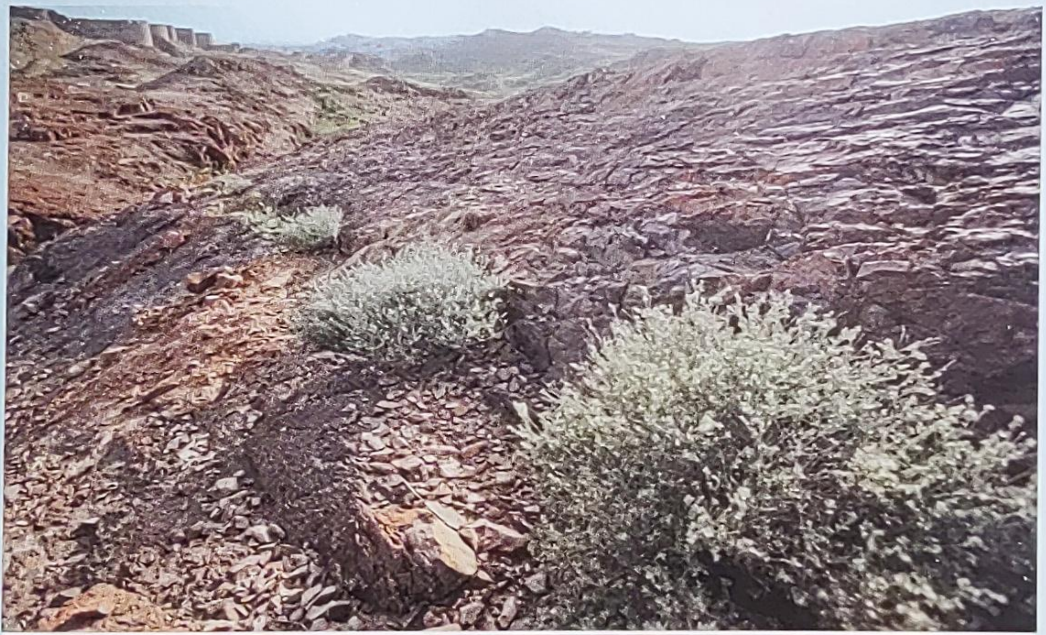
seddera (no local or common names)

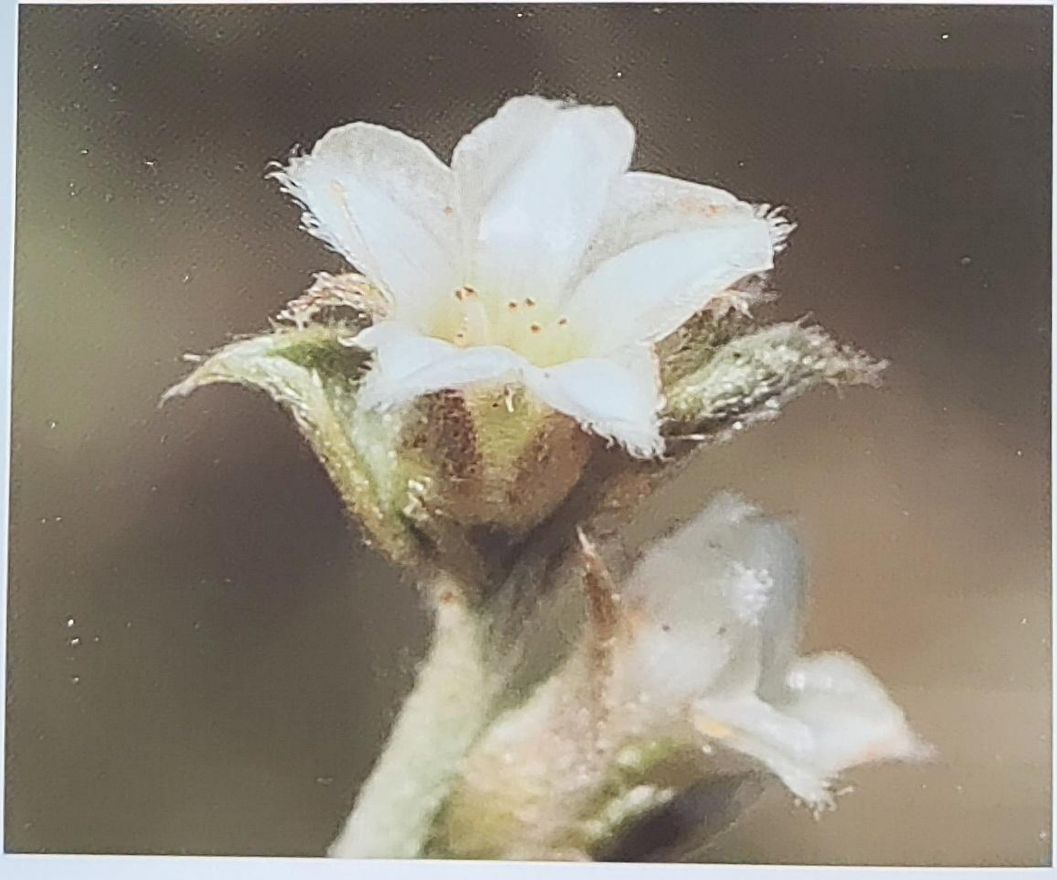
221

Seddera latifolia | FAMILY **Convolvulaceae**

HABITAT **Crevices in rock** ✿ OCT–MAR

One of the hardiest plants of the Thar desert, able to survive in dry, bare rock. You can sometimes see it growing in straight lines, following minute fissures in volcanic rhyolite where it is able to access minuscule quantities of soil-dust and perhaps a little moisture. It is likely (though we are not yet certain) that it is somehow able to utilise atmospheric dew to meet its requirements of moisture. Seddera has tiny white flowers that are intensely hairy when you look at them through a hand lens. It is surprisingly easy to germinate the seeds.

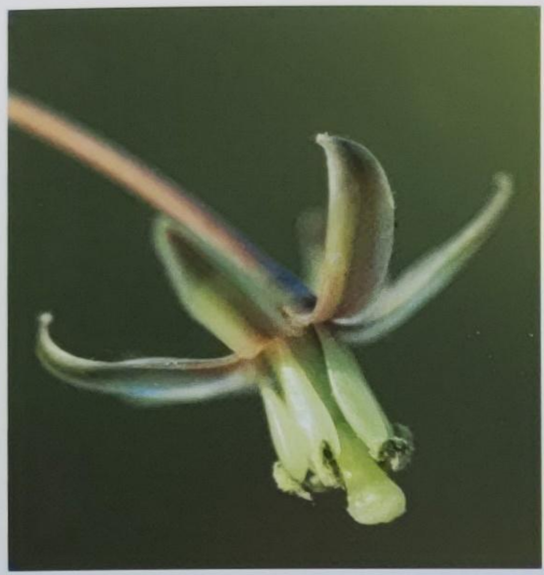


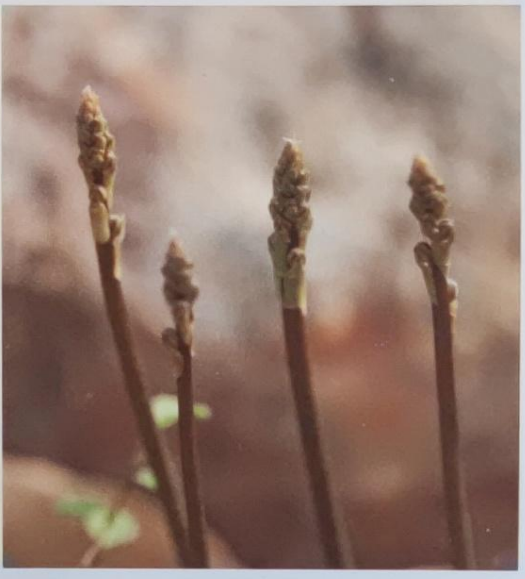


jungli pyaaz indian squill 243

Drimia indica | FAMILY Liliaceae

HABITAT Rocky or gravelly places ✿ APRIL



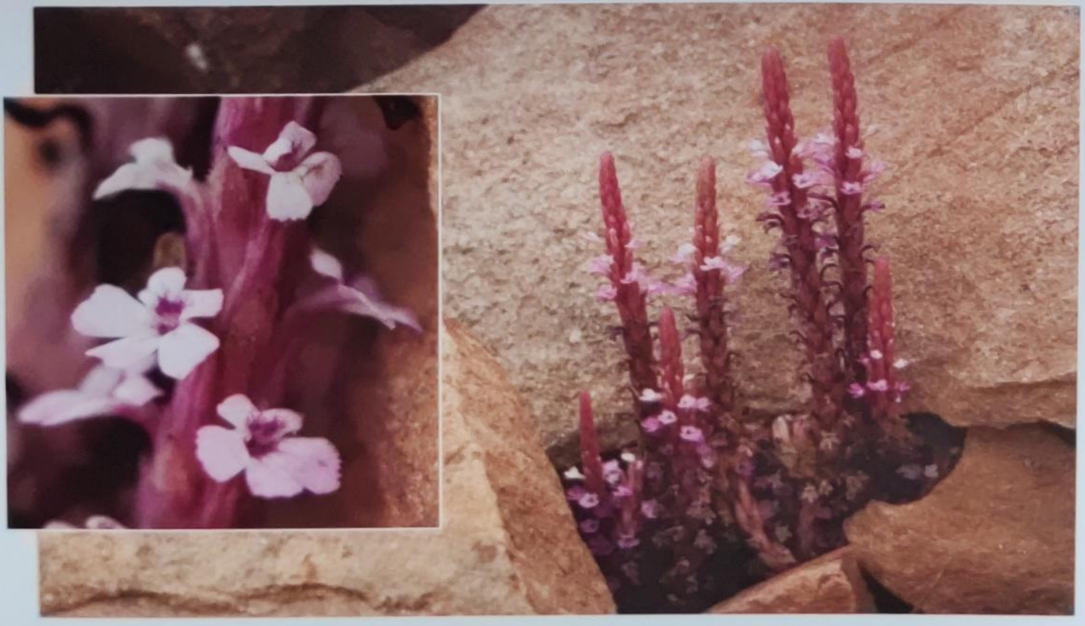


This lily is called jangli pyaaz (wild onion) because of its large, onion-like underground bulb. The flowers are sometimes referred to as 'dingy lilies' because they disdain bright, attractive colours and open only at night, fading by first light. Jungli pyaaz is highly esteemed in traditional Ayurvedic medicine and is widely distributed from the middle east to Africa.

missi cowpea witchweed 230

Striga gesnerioides | FAMILY Scrophularaceae

HABITAT Rocky areas ✿ AUG–SEP



Missi is in some contexts regarded as a pesky weed because it parasitizes wheat and millet crops but it behaves in exemplary fashion in the desert, growing on the roots of thhor bushes and doing them no harm at all. The pretty, pink flowers appear in the rains, then quickly turn into fruit before disappearing.

geedar tambaku

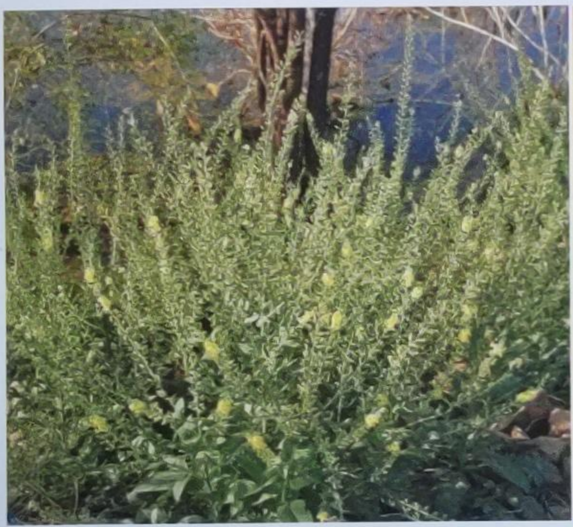
244

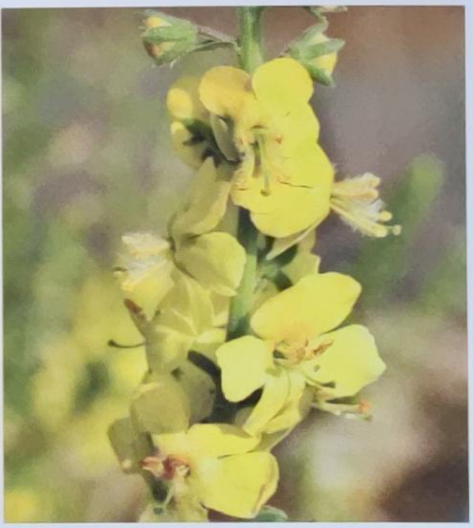
chinese mullein

Verbascum chinense | FAMILY Scrophularaceae

HABITAT **Sandy edges of riverbeds** ✿ FEB–MAY

A one metre tall annual that comes up in winter at the edges of tanks and streams. The local name means 'jackal's tobacco' and refers to its lobed, tobacco-like leaves at the base of the plant. The plant can look very pretty with masses of large, yellow flowers borne all along its tall, erect stems, devoid of leaves.





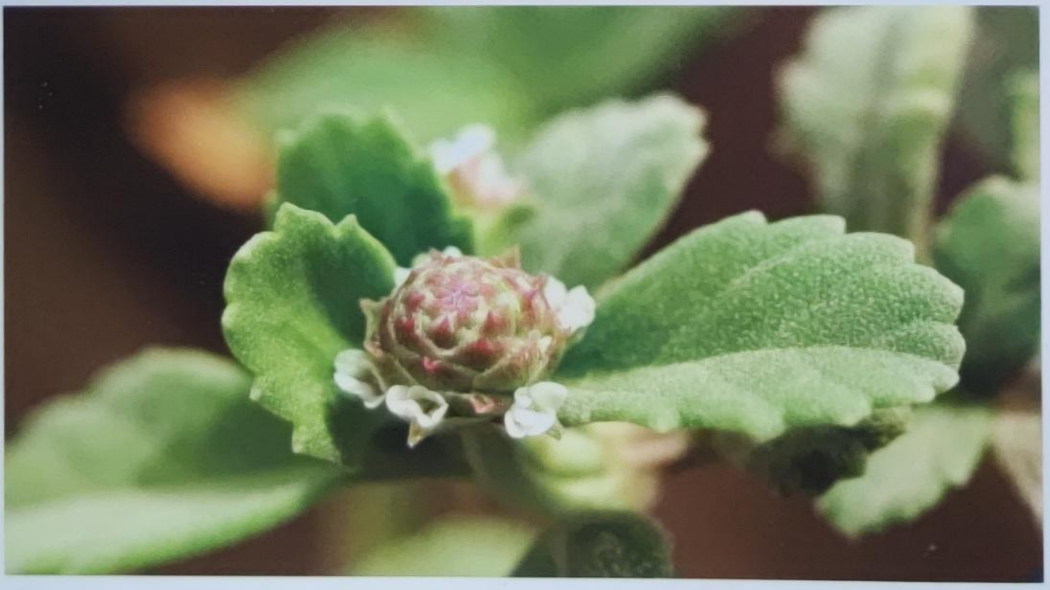
---

jalbooti frog fruit

206

Phyla nudiflora | FAMILY Verbenaceae

HABITAT **Moist margins of ponds** ✿ ALL YEAR



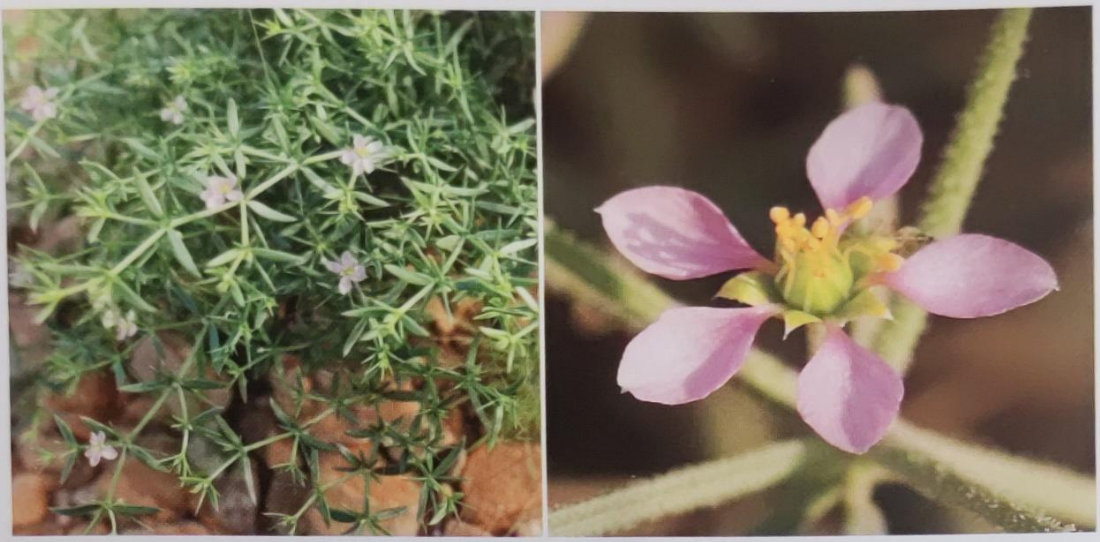
Jalbooti is native to the Americas but has become naturalized in damp places throughout the warm tropics. You can sometimes see it growing in extensive turflike mats at the edges of ponds or marshy areas. Tiny white flowers surounding a fleshy central axis are attractive. Jalbooti is also called 'sawtooth fogfruit', 'turkey tangle' and 'matchweed' in English.

dhamaso indian fagonbush

178

Fagonia indica | FAMILY Zygophyllaceae

HABITAT Gravel plains and sand ✿ SEP–MAR



A hardy, small undershrub found on gravel, clay or sand in the desert in a vast native range stretching across the middle east to the Sahara in northern Africa. The purple or lilac flowers with long-clawed petals attract a host of small insects to pollinate them. The curious fruits are shaped like one of those fanciful Russian ribbed domes that you see in postcards of Red Square.

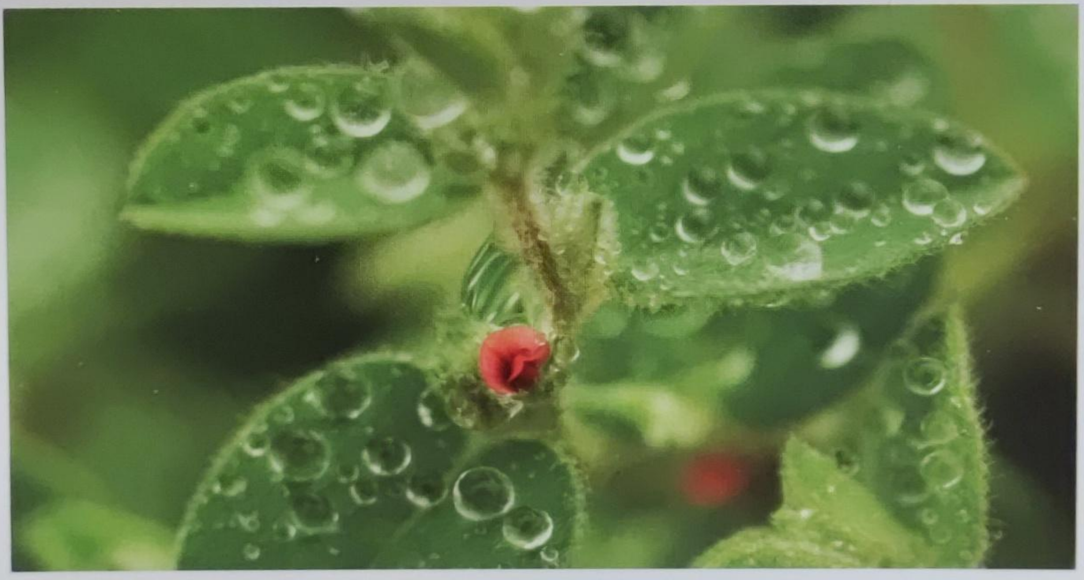
---

bekario heart-leaf indigo

136

Indigofera cordifolia | FAMILY Fabaceae

HABITAT Sand and rock ✿ AUG–NOV



This is without any doubt the most widespread ephemeral herb of the Thar desert, germinating with the first rains and quickly covering sand dunes and gravelly slopes alike. In the record rains of 2010, bekario blanketed dunes in south Jaisalmer to the extent that the sand was no longer visible. You have to peer closely to notice tiny red flowers which are pea-like in form and very pretty. Long after it has died out, bekario leaves a grey fuzz behind in the sand.

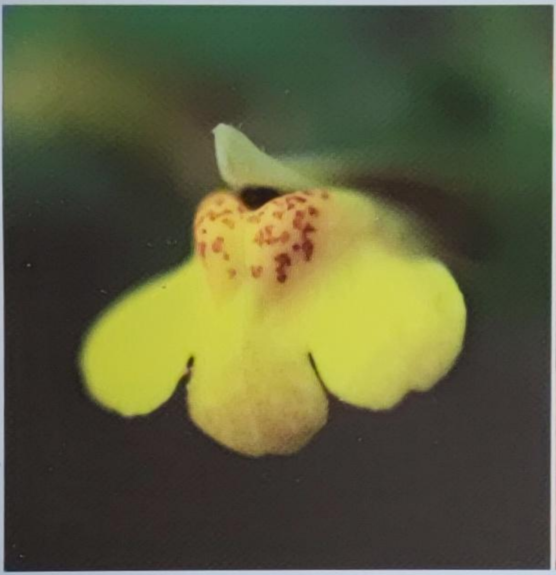
pindru wall lindenbergia

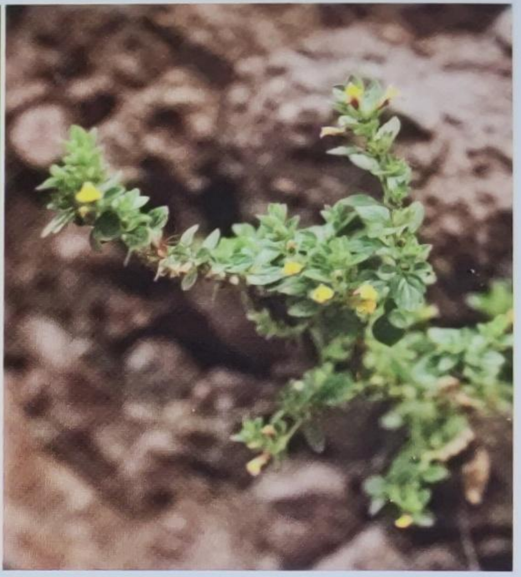
194

Lindenbergia muraria | FAMILY Orobanchaceae

HABITAT **Rocks and old walls** ✿ SEP–MAR

Pindru (also: basanti) has a curious habit of appearing in the grouting of walls in old monuments, as if it has a nose for history. A liking for lime mortar is probably the reason but it also likes dry, rocky areas in general. The small, bright, 3-lipped yellow flowers with red spots are worth looking at closely with a hand lens.





---

oont kantalo (2)

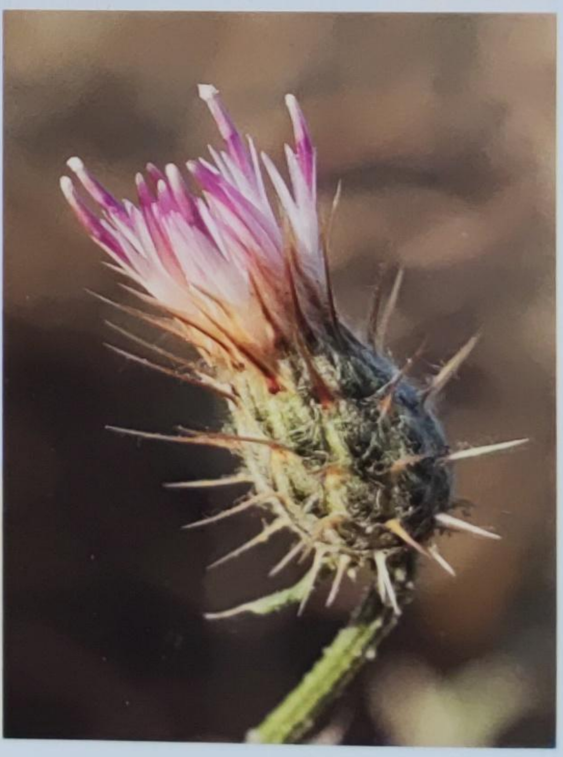
knapweed

200

Oligochaeta ramosa | FAMILY Asteraceae

HABITAT **Wastelands, disturbed sites** ✿ OCT–MAR

Like the globe thistle (*Echinops*) this plant also goes by the name 'oont kantalo'. One of the places you are most likely to find it growing wild is around ruins of old buildings or along dry, gravelly roadsides. It is easy to walk past this oont kantalo without paying it a second glance but the flower heads are most interesting when seen close up.

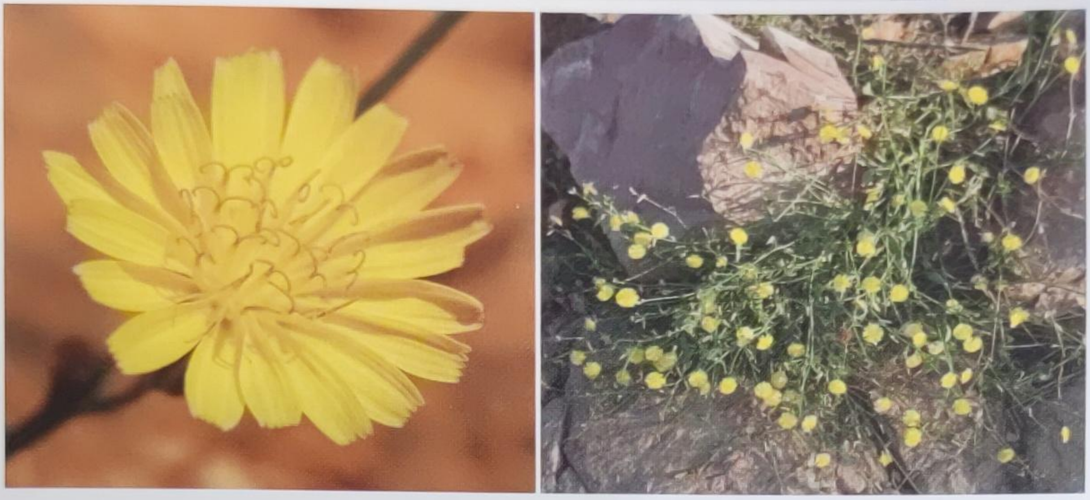


jungli gobi creeping launea

189

Launaea procumbens | FAMILY Asteraceae

HABITAT Abandoned fields, wastelands ✿ OCT–JUN



A small, prostrate herb with gay, yellow flowers borne in great profusion. Jangli gobi (also: van gobi) is easy to confuse with 3 other species of *Launaea* found in the Thar desert, as well as *Sonchus*, all of which have bright yellow dandelion-like flowers. Both *Launaea* and *Sonchus* tend to inhabit waste spaces and abandoned fields and are sometimes found growing in rocky sites as well.

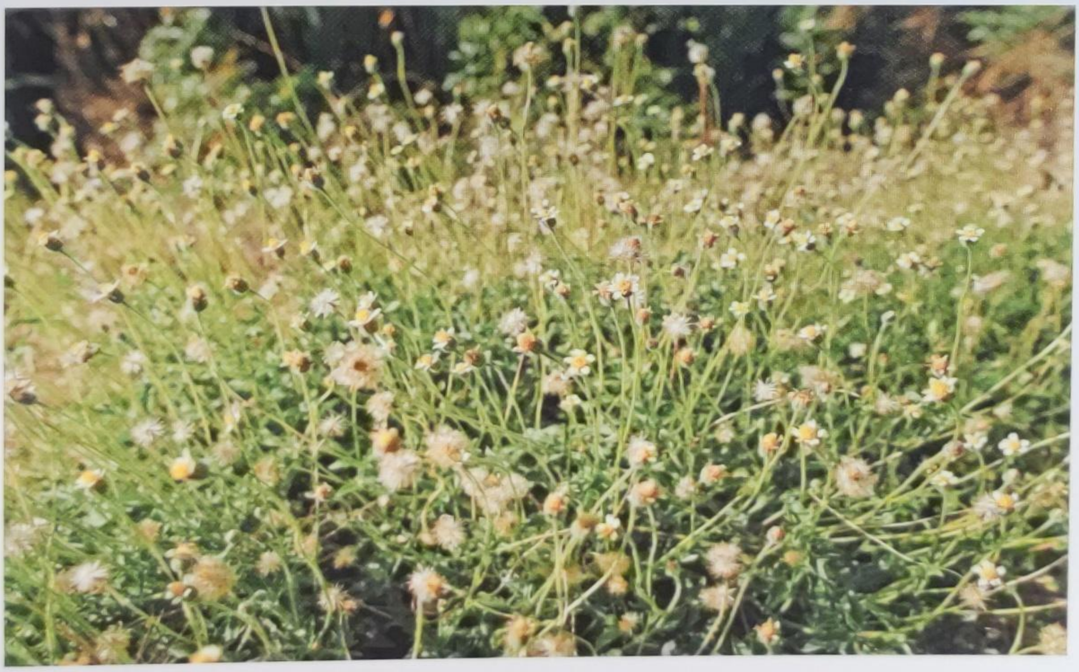
---

ghamra coat buttons

240

Tridax procumbens | FAMILY Asteraceae

HABITAT Waste places and roadsides ✿ MAY–JAN



A small annual with low, spreading (hairy) branches and erect flowering stems. The centre of the flowering head is yellow, the outer ray petals pure white. Ghamra is sometimes considered an invasive pest but can brighten up difficult sites and the plant has a host of medicinal and healing uses too. Ghamra is a favourite forage-plant for many different species of butterfly.

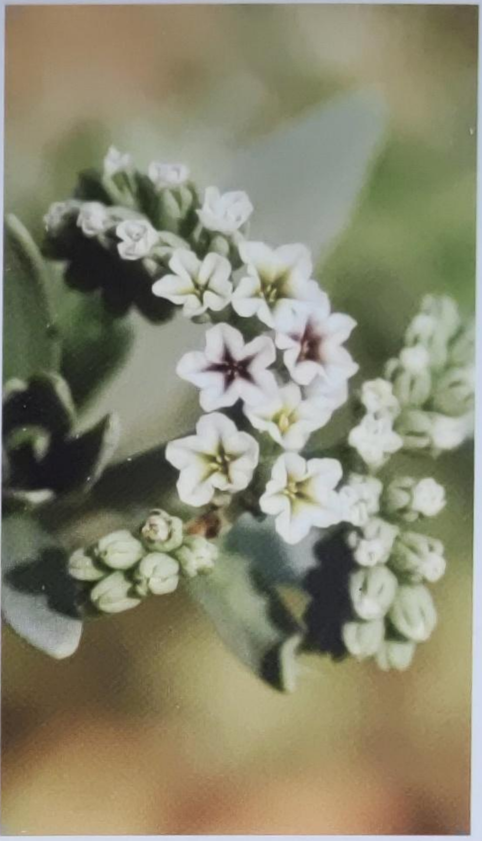
kunden grey leaf heliotrope

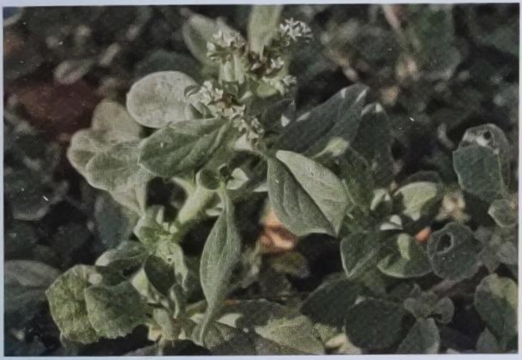
184

Heliotropium ovalifolium | FAMILY Boraginaceae

HABITAT Rocky or sandy places ✿ NOV–JUN

A small, common desert herb from a very large genus known as 'heliotropes' because they orient their flowers towards the sun. The tiny flowers are arranged in peculiar structures like the arms of an octopus, called 'scorpioid cymes'. Although kunden prefers to grow near the dry margins of water-bodies, you will sometimes find lone plants growing in dry spots in pure rock.





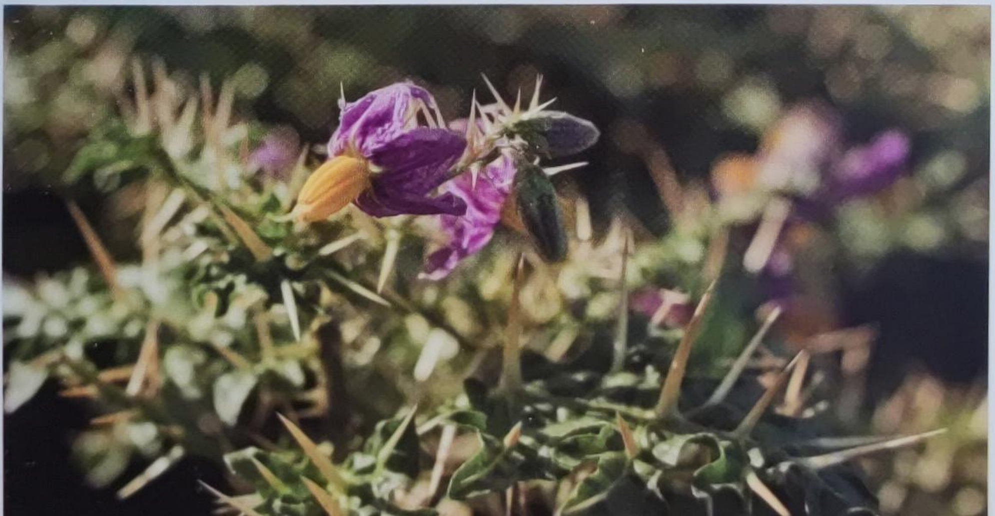
---

ringani thorny nightshade

226

Solanum virginianum | FAMILY Solanaceae

HABITAT Rocky or sandy places ✿ ALL YEAR



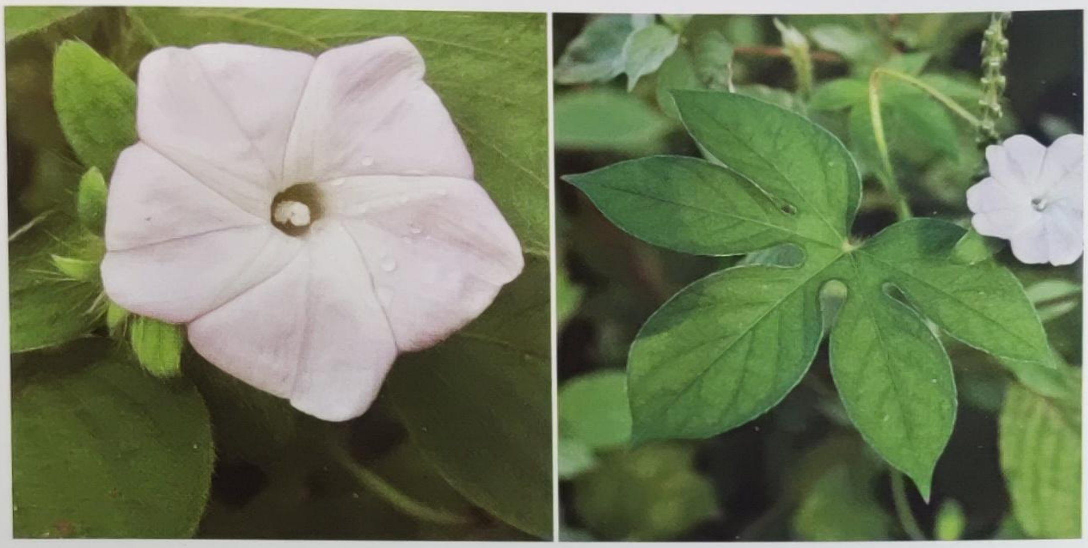
An immensely prickly, low, perennial shrub that springs up unbidden on disturbed ground. You often find it growing in waste rubble near stone mines. Ringani (also: bhatkataiya, bhoo ringani, kateli) sports deep purple flowers most of the year and is an unmistakable relative of the baingan or eggplant.

santari tigerpaw morning glory 309

Ipomea pes-tigridis | FAMILY Convolvulaceae

HABITAT Rocky or gravelly places ✿ SEP–OCT

Santari is a fairly common twining annual that comes up in the rains and flowers handsomely immediately afterwards. The deeply lobed leaves are thought to evoke the impression of a tiger's pugmark, a useful way to distinguish it from many other morning glories that flower at the same time. The petals are the faintest shade of lilac possible and open in the evening.

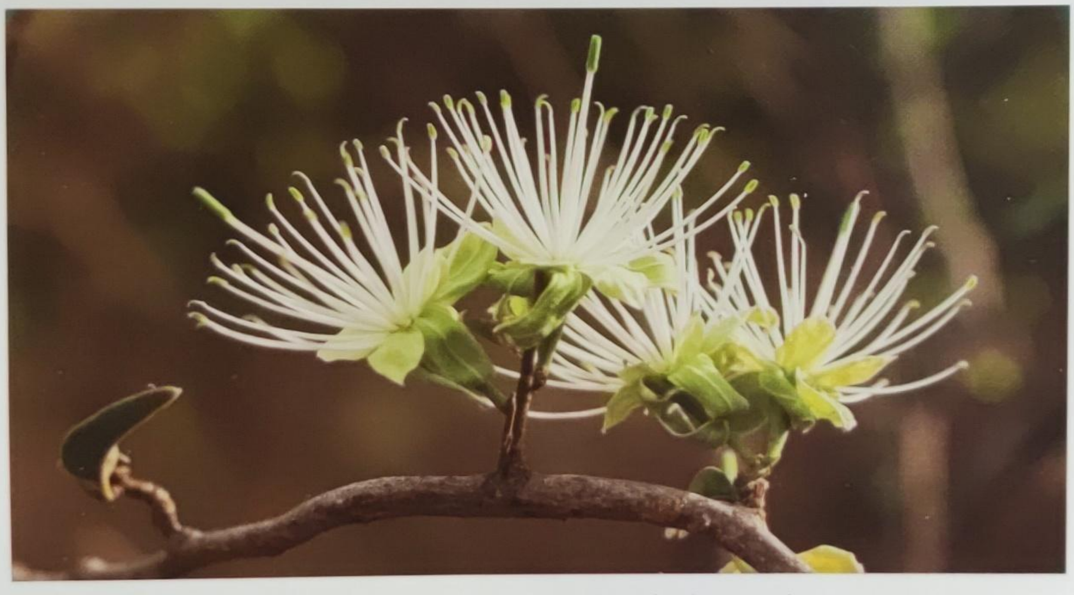


---

orapa desert bush-cherry 311

Maerua oblongifolia | FAMILY Capparaceae

HABITAT Dry areas generally ✿ MAR–APR

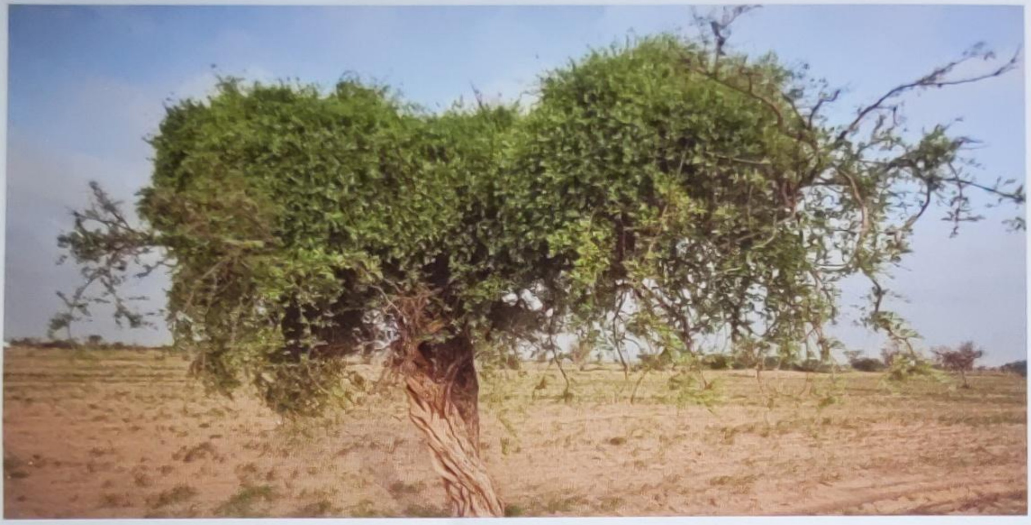


Orapa (also: hemkand) is a strong climber with a thick, woody stem, not very common in the desert. It attracts attention by its opulent long-stamened flowers. One of orapa's peculiar attributes is that the leaves on young shoots do not look at all like the adult leaves, making it hard to recognize unless you are aware of the disguise. The fruits are like a long, sticky string of knotty berries.

peelvaan weeping cockle 303

Cocculus pendulus | FAMILY Menispermaceae

HABITAT Sandy or rocky places ✿ NOV–DEC



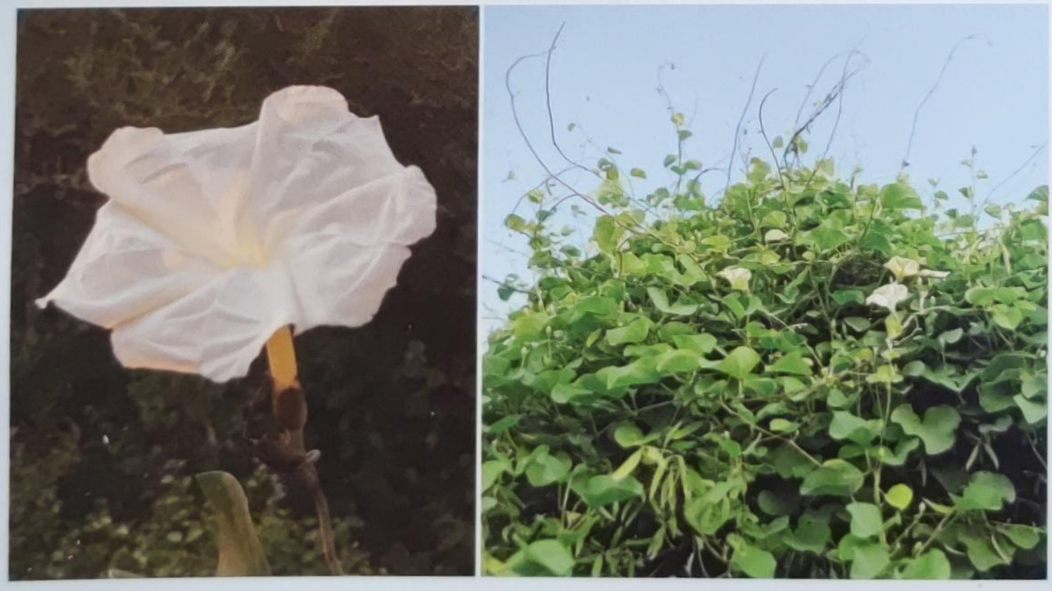
When you drive through a sandy landscape in the Thar, this is the most common climber you are likely to see, twining on khejdi trees. Small-leaved and with tiny, inconspicuous flowers, peelvaan looks immensely attractive in new leaf when it develops a grey-green canopy with a silvery sheen. Peelvaan is also capable of growing in rock crevices if it can find purchase in soil, and in good examples of such sites it forms great cascades of leaves tumbling down the rock.

---

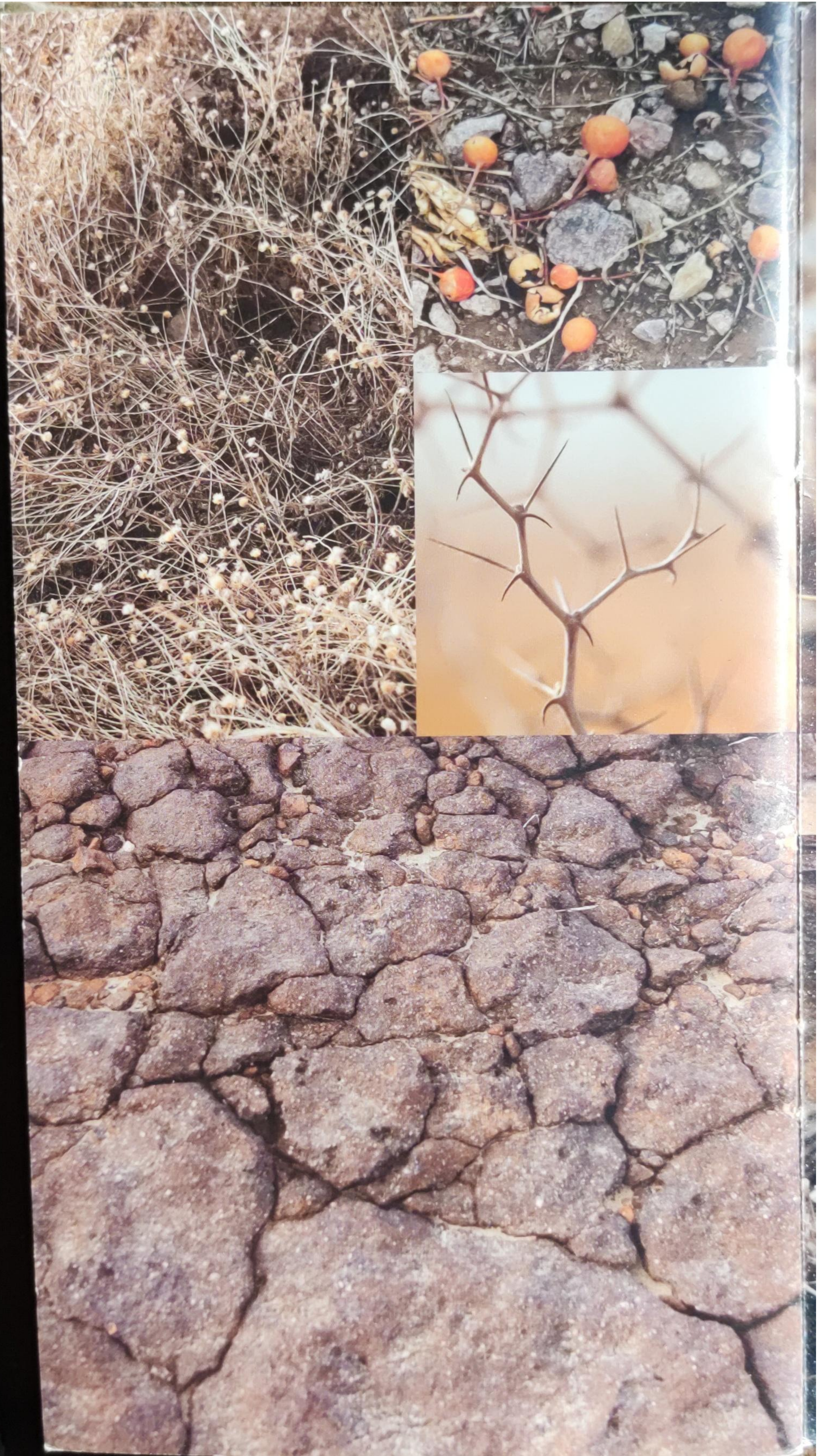
rotabel midnapore creeper 334

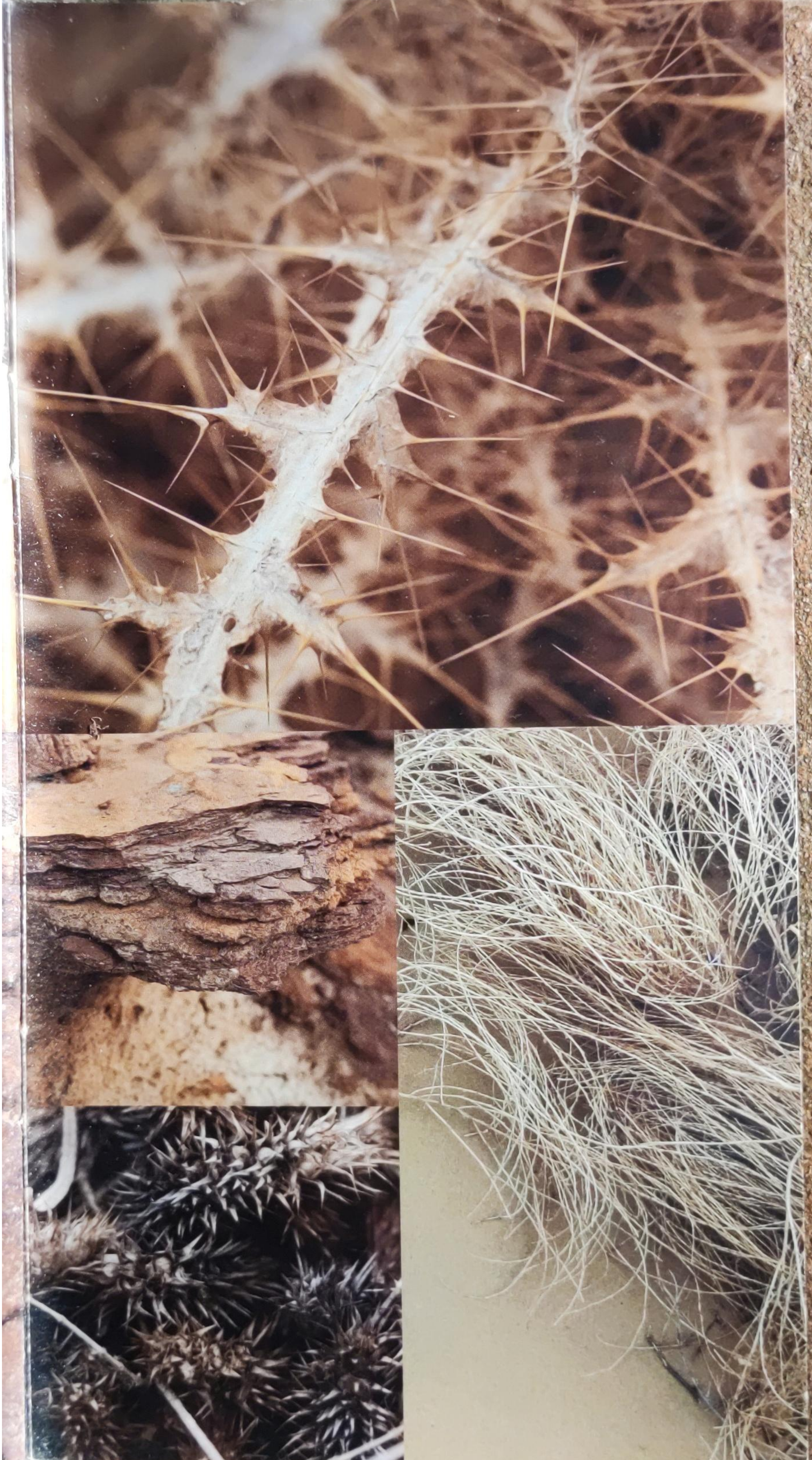
Rivea hypocrateriformis | FAMILY Convolvulaceae

HABITAT Rocky or gravelly places ✿ AUG–NOV



Rotabel (also: phang, phanji) is the 'moonflower' of the Indian desert, opening at dusk and emitting a perfect perfume to elicit attention from the night-flying moths who seek it out. It can become a large, woody climber, inconspicuous except when it springs to life in the rainy season. The pure white flowers are among the loveliest of desert blooms.





FRONT COVER: Oont Kantalo (*Echinops echinatus*)
BACK COVER: Vajradanti (*Barleria acanthoides*)

ISBN 978-81-910471-3-4

www.raojodhapark.com